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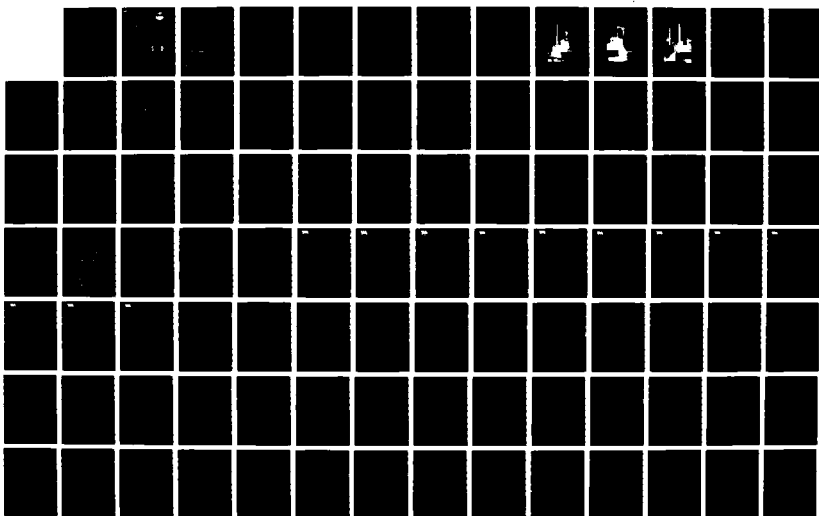
COMPLIANCE TESTING OF GRISSOM AFB CENTRAL HEATING PLANT 1/2
COAL-FIRED BOILER. (U) AIR FORCE OCCUPATIONAL AND
ENVIRONMENTAL HEALTH LAB BROOKS AF.. J A GARRISON

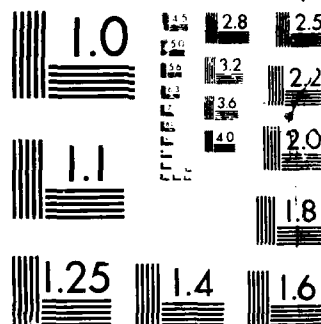
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USAFOEHL REPORT

88-050EQ0025CEF



AD-A195 220

**Compliance Testing of Grissom AFB Central
Heating Plant Coal-Fired Boilers 3 and 4,
Grissom AFB IN**

JAMES A. GARRISON, Maj, USAF, BSC

March 1988

Final Report

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**USAF Occupational and Environmental Health Laboratory
Human Systems Division (AFSC)
Brooks Air Force Base, Texas 78235-5501**

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This report has been reviewed and is approved for publication.


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19. ABSTRACT (Continue on reverse if necessary and identify by block number) At the request of HQ SAC/SGPB, compliance testing (particulate emission) of coal-fired boilers 3 and 4 in the Grissom AFB central heating plant was performed on 18-23 Nov 1987. The survey was conducted to determine compliance with Indiana Administrative Code, Title 325--Air Pollution Control Board, Articles 5 and 6. Results indicate Boiler 3 met particulate standards while exhausting through the bypass stack, but failed to meet standards when exhausting through the scrubber stack. Boiler 4 met particulate standards when exhausting through both the bypass and scrubber stacks.					
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I. INTRODUCTION

On 18-23 Nov 87, a stationary source sampling survey for particulate emissions was conducted on coal-fired boilers 3 and 4 at the Grissom AFB Central Heating Plant, by the Air Quality Function of the USAF Occupational and Environmental Health Laboratory (USAFOEHL). This survey was requested by HQ SAC/SGPB to determine particulate emission compliance status with regards to Indiana Administrative Code, Title 325 - Air Pollution Control Board, Article 5, Opacity Regulations (325 IAC 5), and Article 6, Particulate Regulations (325 IAC 6). Personnel involved with on-site testing are listed in Appendix A.

II. DISCUSSION

A. Background

On 7 Nov 1986, the Director, Air and Radiation Division, U.S. Environmental Protection Agency (EPA), Region V, issued a notice of violation (NOV) to Grissom AFB for violation of 325 IAC 5, Opacity Regulations. The NOV was based on information submitted by the State of Indiana Department of Environmental Management and by the EPA. Observations indicated that boilers 3 and 4 and oil-fired boiler 1 were out of compliance with respect to visible emissions.

To demonstrate and maintain compliance with 325 IAC 5 and other rules set forth by the Indiana Air Pollution Control Board, EPA, Region V required Grissom AFB to: (1) conduct stack particulate emission testing on boilers 3 and 4 as specified in Title 40, Code of Federal Regulations, Part 60(40 CFR 60), Appendix A, Reference Method 5, (2) determine visible emissions from boilers 1-4 as specified in 40 CFR 60, Appendix A, Reference Method 9 and (3) request stack testing following future major modifications to the central heating plant.

B. Site Description

The Central Heating Plant operates a total of five boilers for steam production:

Boiler No.	Manufacturer	Steam Capacity		Year Installed	Fuel
		lb/hr			
1	Springfield Boiler Co.	40,000		1955	oil
2	Springfield Boiler Co.	40,000		1955	oil
3	Springfield Boiler Co.	40,000		1955	coal
4	E. Keeler Co.	40,000		1960	coal
5	Zurn Ind.	65,000		1980	coal

Boilers 3 and 4 are spreader-stoker fired units with each having forced-draft and induced-draft fans and mechanical fly-ash collection systems. The purpose of the forced-draft fan is to supply air for combustion and that of the induced-draft fan is to maintain a negative draft condition in the furnace part of the boiler for combustion and removal of gases and to provide a positive static pressure at flue gas exhaust discharge points. The ash system pneumatically removes ash from bottom-ash hoppers, sifting hoppers and mechanical collector hoppers. Both units are fitted with a steam-operated soot blower to remove fly-ash and soot from heat exchanger tubing.

Air pollution control consists of individual cyclonic dust collectors on each boiler and a wet scrubber common to the three coal-fired boilers. The multiclone dust collector, Model 9VM-10, is manufactured by Western Precipitation Division - Joy Manufacturing Co. Each collector consists of 36 nine-inch diameter cyclonic collectors operating in parallel. The units are located in the boiler exhaust duct upstream of the induced-draft fan. Ash collected by the multiclones is carried by gravity to a hopper.

The exhaust effluent from each boiler is ducted to a common breeching and can be routed to the wet-scrubber or to a bypass stack. The scrubber is a double-alkali flue-gas desulfurization system using soda ash(sodium carbonate) in the scrubbing fluid and lime (calcium hydroxide) slurry for regeneration of the scrubbing liquid. The primary purpose of the unit is to remove sulfur from the flue gases; a secondary purpose is to remove particulates from the flue gases. The system has two identical scrubber units each designed to handle 50% of the flue gases from the three coal-fired boilers. Each unit has a 5 ft diameter stack and terminates about 70 feet above the ground. There is no requirement at this time to use the scrubber system because of the low-sulfur coal being used by the plant. The bypass stack has a 5.5 ft diameter and terminates approximately 70 ft above ground level. The scrubber stacks and the bypass stack can be seen in Figures 1, 2 and 3. A flue gas flow diagram is shown in Figure 4.

C. Applicable Standards

The monitoring requirements, opacity regulations and particulate regulations are defined under 325 IAC 3, 5 and 6 respectively. Article 5 states that visible emissions shall not exceed an average of 40% opacity in 24 consecutive readings or 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

Under 325 IAC 6, the maximum allowable particulate emission rate from the combustion of fuel for indirect heating is determined by the following equation:

$$Pt = \frac{C \times a \times h}{0.75 - 0.25} \\ 76.5 \times Q \times N$$

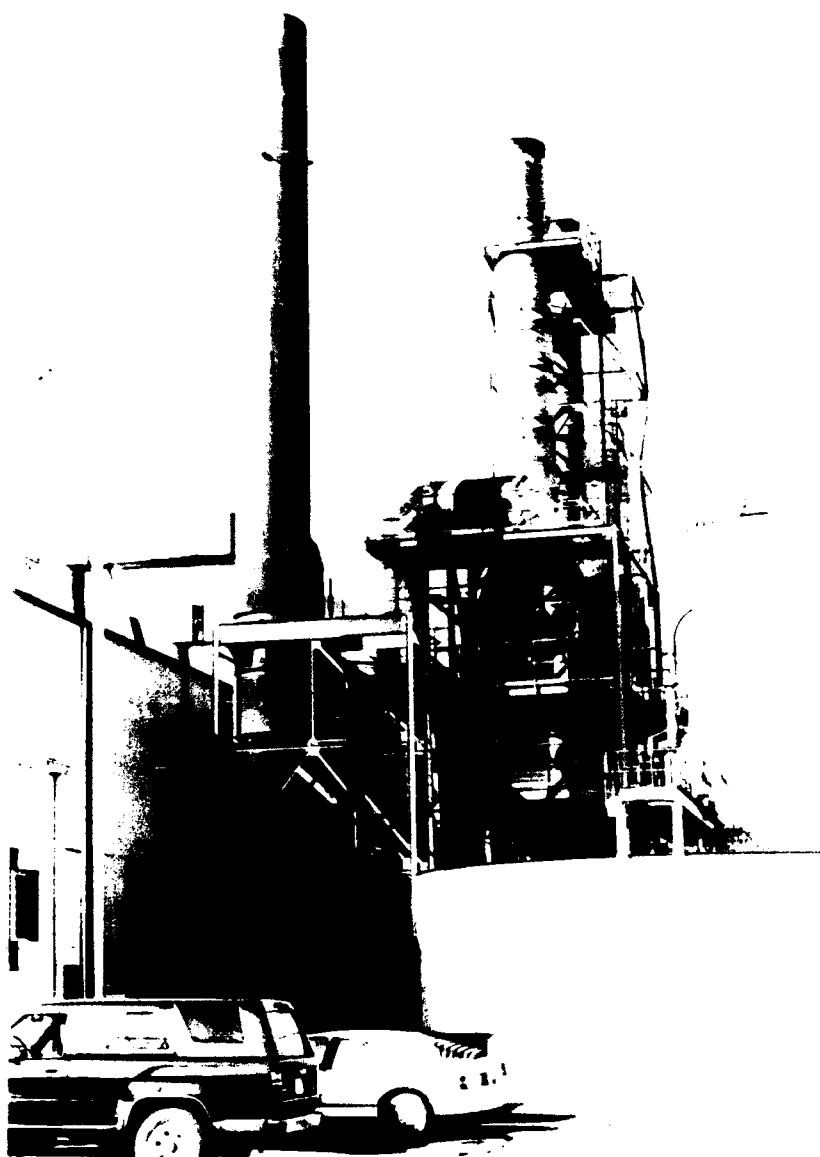


Figure 1. View of Bypass and Scrubber Stacks

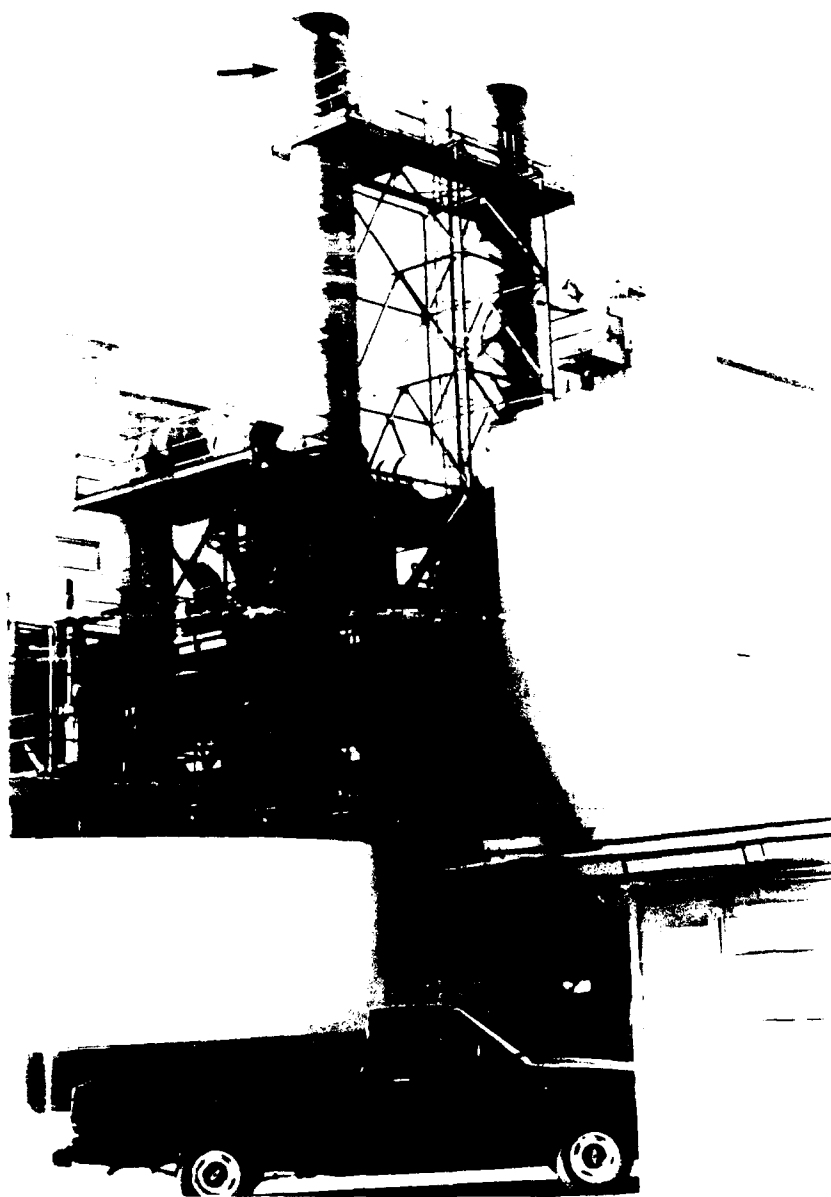


Figure 2. Scrubber Stacks (Scrubber B noted by arrow)

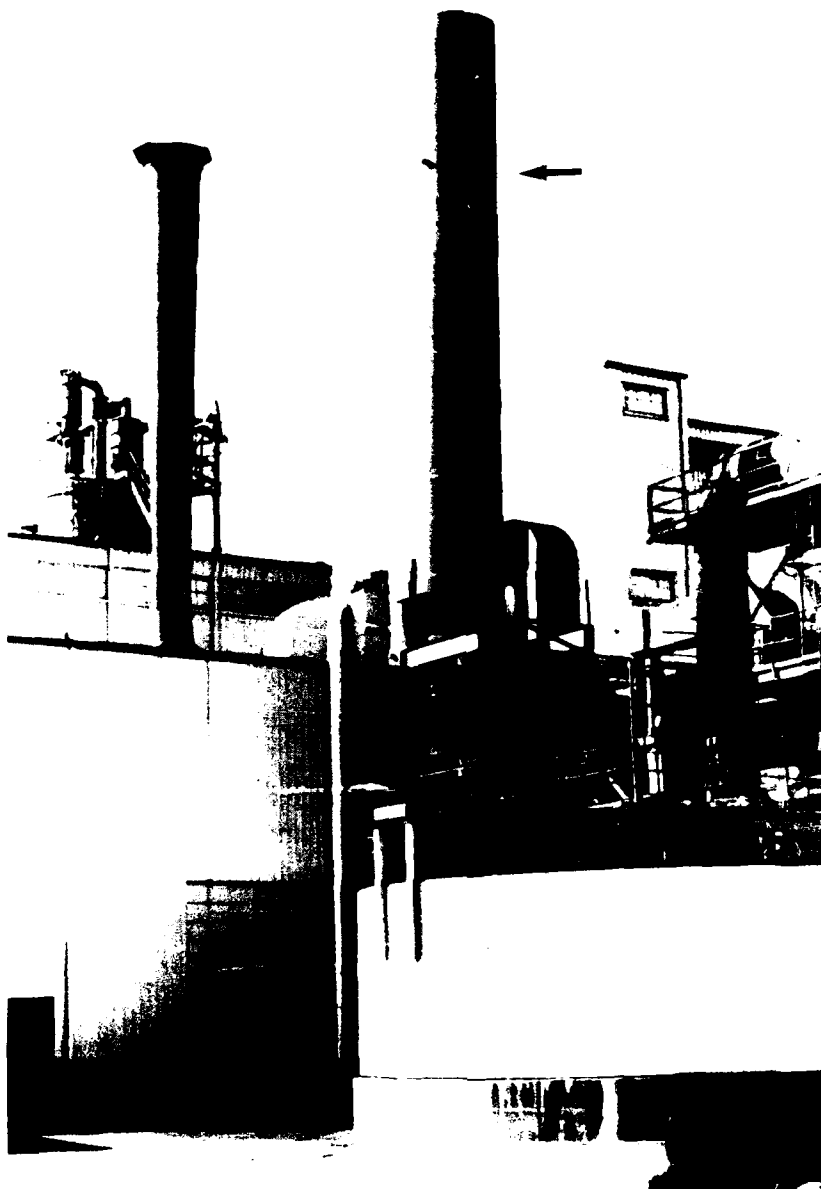


Figure 3. Bypass Stack (Noted by arrow)

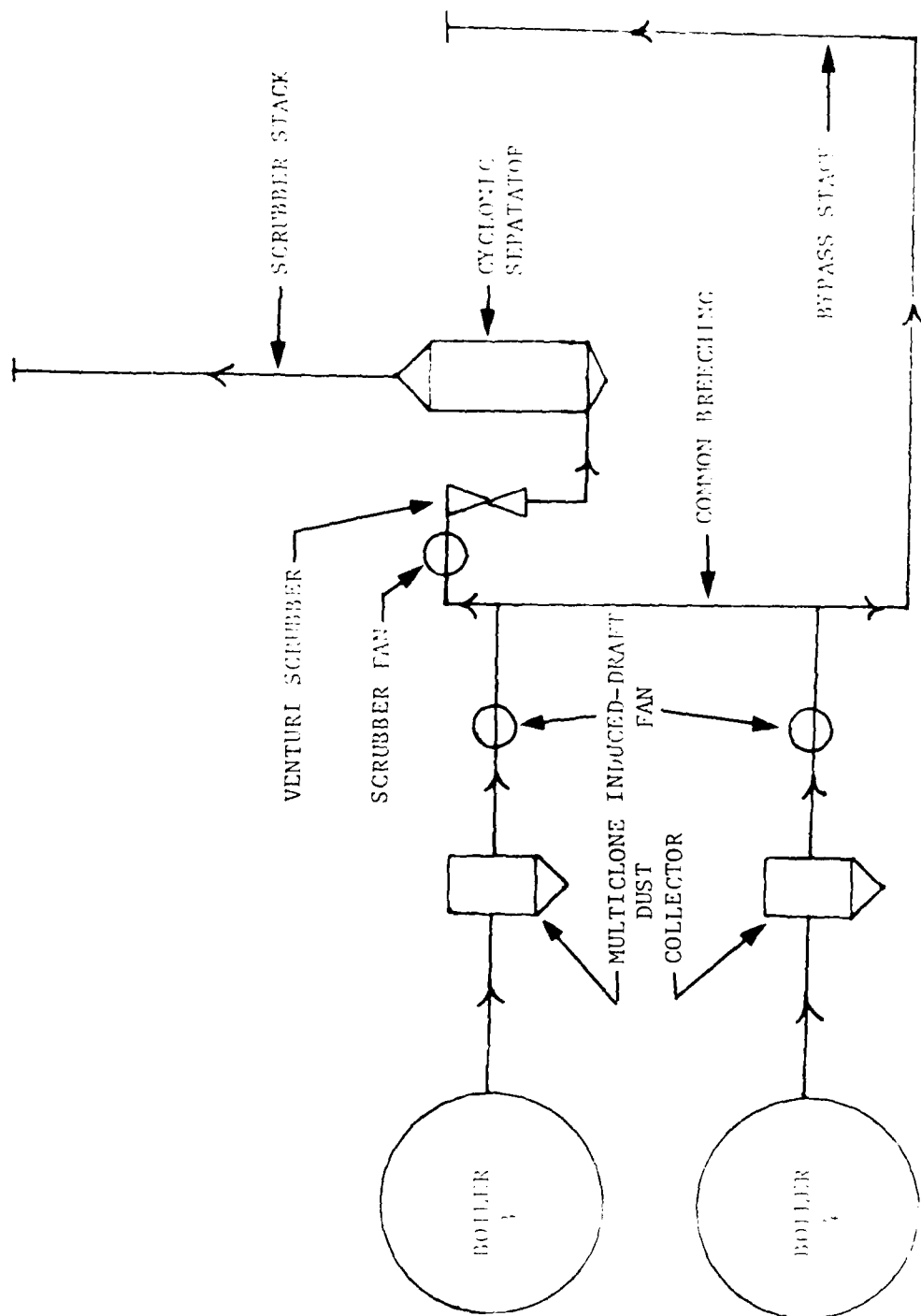


Figure 4. Flue Gas Flow Diagram

Where:

Pt = Pounds of particulate matter emitted per million Btu heat input (lb/mmBtu).

C = Maximum ground level concentration with respect to distance from the point source at the "critical" wind speed for level terrain (50 micrograms per cubic meter-provided in standard).

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input (50.8 mmBtu/hr determined from plant operation).

N = Number of stacks in fuel burning operation (1).

a = Plume rise factor (0.67 used for Q less than or equal to 1,000 mmBtu/hr) heat input.

h = Stack height in feet (70 ft).

The limit on particulate emissions determined by the above equation and values of the variables applicable to this facility is 1.6 lb/mmBtu. However, particulate emissions from facilities used for indirect heating purposes which were existing and in operation on or before June 8, 1972, shall in no case exceed 0.8 lb/mmBtu heat input. State regulations are presented in Appendix B.

D. Sampling Methods and Procedures

Boilers 3 and 4 were tested through both the scrubber and bypass stacks. Only scrubber B was tested since we assumed that it mimicked the operation of scrubber A. Coordination was made with plant personnel to operate each boiler at 95% capacity or greater during testing. One of the three runs which comprised a complete test included a soot blow; this is indicated on the field data sheets. Boiler operating logs for the test periods are provided in Appendix C. These logs indicate hourly steam output and coal usage. Laboratory results for the coal analysis are provided in Appendix D. Each coal sample represents an integrated sample collected over a particular one hour test run as noted on the analysis sheet.

325 IAC 3 requires that all emissions tests be conducted in accordance with the procedures and analysis methods specified in 40 CFR 60, Appendix A, Methods 1-5. Therefore, test methods, equipment, sample train preparations, sampling and recovery, calibration requirements and quality assurance were done in accordance with the methods and procedures outlined in 40 CFR 60, Appendix A.

Inspection of the stacks indicated that sampling ports had already been installed on the scrubber stack and were located 1.4 stack diameters upstream from the stack exit and 5.6 stack diameters downstream from any disturbance (cyclonic separator). Based on a 5 ft inside stack diameter, port location and type of sample (particulate), a total of twenty traverse points were determined for emission evaluation. Sampling ports had to be installed on the bypass stack and were located 2 stack diameters upstream from the stack exit and 7 stack diameters downstream from the nearest disturbance (common breeching inlet). Based on a 5.5 ft inside stack diameter, port location and type of sample (particulate), a total of twelve traverse points were determined for emission evaluation. The sampling time for each sampling run was 60 minutes; therefore, the sampling time for each point in the scrubber stack was 3 minutes and the time for each point in the bypass stack was 5 minutes. Illustrations showing port locations and sampling points are provided in Appendixes E - H.

Prior to every sample run on each stack, a preliminary velocity pressure traverse was accomplished and cyclonic flow was determined. For acceptable flow conditions to exist in a stack, the average of the absolute value of the flow angle taken at each traverse point must be less than or equal to 20 degrees. The flow angle in the bypass stack averaged 15-17 degrees which indicated an acceptable flow condition. Initially, the flow angle in the scrubber stack averaged 24 degrees. This was caused by the tangential entry of the flue gas into the cyclonic separator. Straightening vanes were installed directly above the cyclonic separator which brought the average flow angle to 9 degrees.

During each sample run, a flue gas sample for orsat analysis (measures oxygen, and carbon dioxide for stack gas molecular weight determination) was taken. Orsat sampling and analysis equipment are shown in Figures 5 and 6. Flue gas moisture content, also needed for determination of gas molecular weight, was obtained during particulate sampling.

Particulate samples were collected using the sampling train shown in Figure 7. The train consisted of a button-hook probe nozzle, heated inconel probe, heated glass filter, impingers and pumping and metering device. The nozzle was sized prior to each sample run so that the gas stream could be sampled isokinetically; in other words, the velocity at the nozzle tip was the same as the stack gas velocity at each point sampled. Flue gas velocity pressure was measured at the nozzle tip using a Type-S pitot tube connected to a ten inch inclined-verticle manometer. Type K thermocouples were used to measure flue gas as well as sampling train temperatures. The probe was heated to minimize moisture condensation. The heated filter was used to collect particulate materials. The impinger train (first, third and fourth impingers: modified Greenburg-Smith type, second impinger: standard Greenburg-Smith design) was used as a condenser to collect stack gas moisture. The pumping and metering system was used to control and monitor the sample gas flow rate.

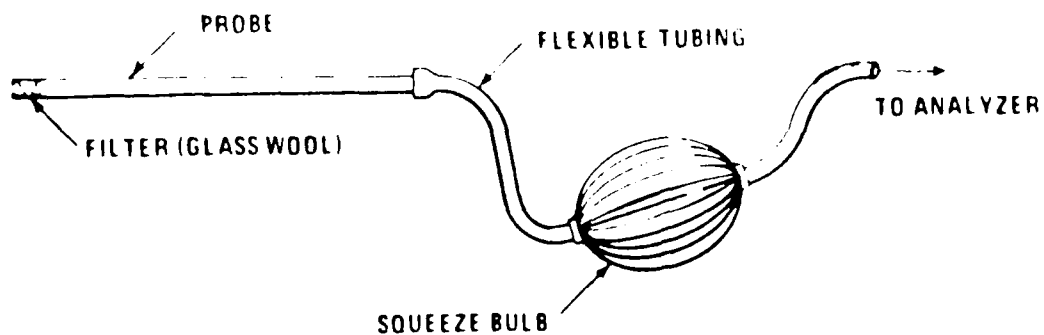


Figure 5. ORSAT Sampling Train

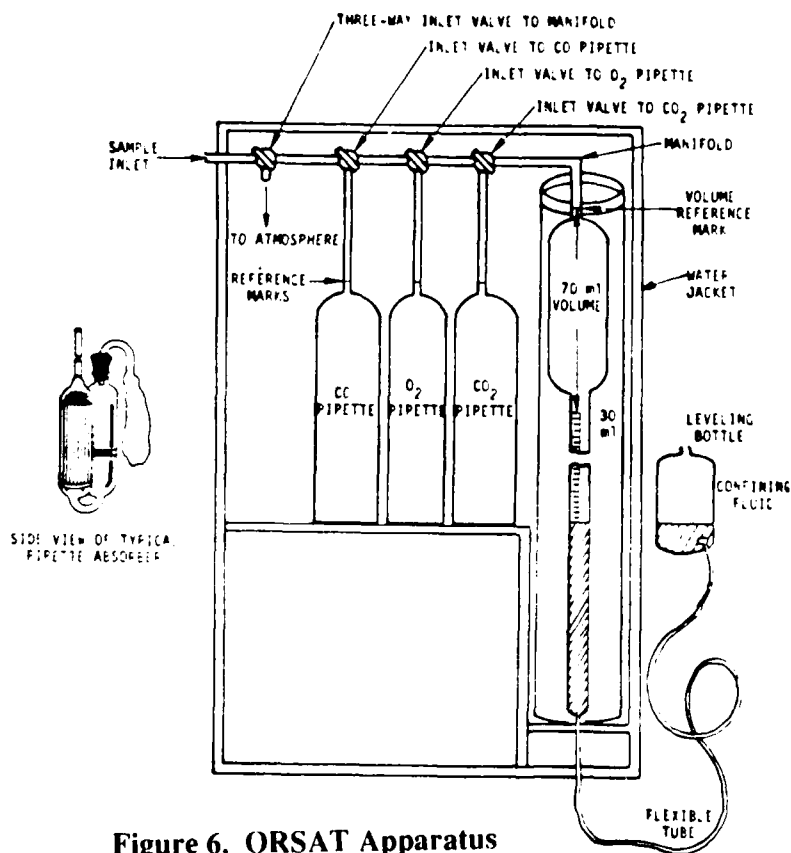


Figure 6. ORSAT Apparatus

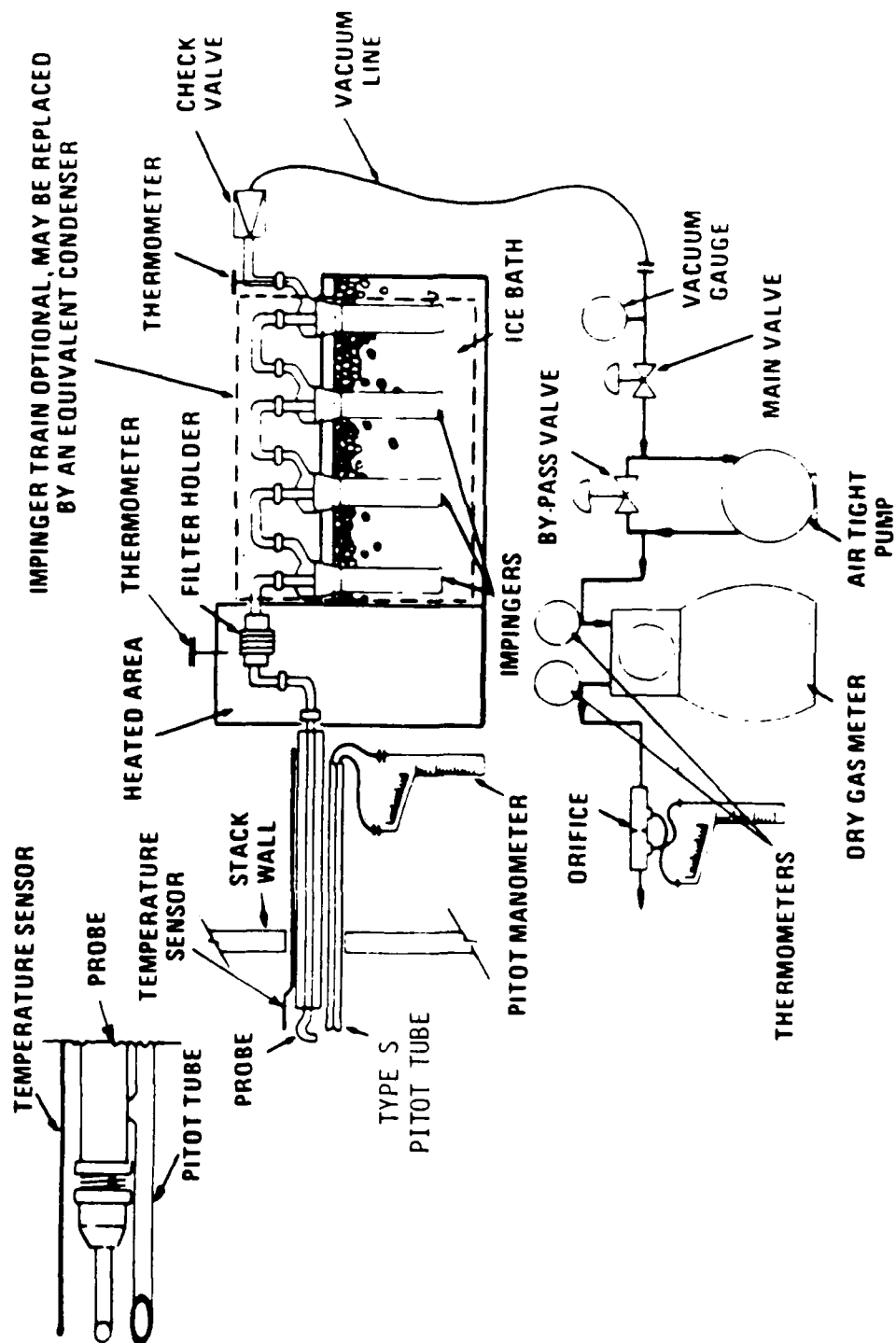


Figure 7. Particulate Sampling Train

Emission calculations were done using two different computer packages. The first of these is entitled "Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators" (EPA-340/1-85-018) developed by the EPA's Office of Air Quality Planning and Standards, Research Triangle Park NC. This has been our standard method for calculating emission data. The second package is entitled "Stack-Pack" and was developed by Mr B.B. Booth, Shasta County Air Quality Management District, Redding CA. Stack-Pack is made for the minicomputer. Since Stack-Pack runs on the minicomputer and provides resultant calculations in a simple report format, we decided to use it for this project. First, however, it was compared to the EPA program for accuracy. We found it compared very favorably and was even slightly more conservative than the EPA programs. Therefore, calculations for this project were made with Stack-Pack. All sampling data and resulting calculations from the Stack-Pack program are presented in Appendixes E-H; calculations from the EPA programs are found in Appendix I. Calibration data is presented in Appendix J.

III. CONCLUSIONS

The following table provides operating parameters for boilers 3 and 4 during testing and the resultant particulate emission rates determined from these tests. Results indicate that boiler 3 and 4 emissions through the bypass stack were well below the emission standard of 0.80 lb/mmBtu with particulate emission rates of 0.32 lb/mmBtu and 0.48 lb/mmBtu respectively. Boiler 3 emissions through the scrubber were above the standard with an emission rate of 4.18 lb/mmBtu. Boiler 4 emissions through the scrubber were below the standard with an emission rate of 0.69 lb/mmBtu.

We believe a number of factors contributed to the high particulate loading experienced with boiler 3 scrubber emissions: (1) the low percentage of carbon dioxide(CO_2) in the effluent and (2) the fact that material collected on the filter probably contained soda ash residue from the scrubber. The low percentage of CO_2 found in the flue gas contributed to the high emission rate since this rate is corrected to 12% CO_2 . Probable cause of the low CO_2 value was: (1) scrubber liquid absorbing CO_2 from the flue gas and (2) outside air being drawn into the scrubber through the bypass stack. However, low CO_2 was not the primary factor since boiler 4 emissions through the scrubber were below the standard with essentially the same low percentage of CO_2 in the gas stream. Also, boilers 3 and 4 performed essentially the same through the bypass stack.

It appears that the primary cause for the high emission rate was an upset in the operation of the scrubber such as too high a concentration of soda ash in the scrubbing liquid, thereby causing a carry-over of lime out of the stack.

STACK EMISSION TESTING RESULTS

DATE	TIME (MILITARY)	BOILER NO.	STACK NO.	RUN NO.	BOILER OPERATING CAPACITY (%)	SOOT BLOW	COAL HEAT VALUE (Btu/lb)	COAL USE (lb/hr)	HEAT INPUT (mmBtu/hr)	*PM EMISSIONS (lb/hr)	PM EMISSIONS (lb/mmBtu)
18 NOV 87	1430	3	**BP	1	100.0		11,066	4,444	49.2	14.27	0.29
19 NOV 87	1002	3	BP	2	100.0		11,162	4,427	49.4	14.54	0.29
20 NOV 87	0855	3	BP	3	99.0	X	11,571	4,389	50.8	19.41	0.38
					AVG = 100.0					AVG = 16.07	AVG = 0.32
23 NOV 87	0830	3	***SC	1	98.0	X	11,439	4,333	49.6	359.87	7.26
23 NOV 87	1000	3	SC	2	90.0		11,409	4,000	45.6	140.16	3.07
23 NOV 87	1136	3	SC	3	93.0		11,474	4,111	47.2	103.80	2.20
					AVG = 94.0					AVG = 201.23	AVG = 4.18
21 NOV 87	0924	4	BP	1	98.0		10,834	4,363	47.3	23.02	0.49
21 NOV 87	1201	4	BP	2	98.0	X	11,302	4,375	49.4	29.85	0.60
21 NOV 87	1415	4	BP	3	97.0		11,464	4,305	49.4	17.57	0.36
					AVG = 98.0					AVG = 23.48	AVG = 0.48
22 NOV 87	1115	4	SC	1	96.0		11,334	4,278	48.5	41.65	0.86
22 NOV 87	1313	4	SC	2	98.0	X	11,356	4,333	49.2	49.57	1.01
22 NOV 87	1500	4	SC	3	94.0		11,495	4,183	48.1	9.48	0.20
					AVG = 96.0					AVG = 33.57	AVG = 0.69

* PARTICULATE EMISSIONS
 ** BYPASS STACK
 *** SCRUBBER STACK

IV. RECOMMENDATIONS

It is our recommendation that flue gas from the coal-fired boilers continue to be routed through the bypass stack and that the scrubber not be used until retesting conducted to determine the high stack emissions. The scrubber system will be evaluated when we conduct stack emission testing on boiler 5 during March 1988. At this time we will evaluate inlet/outlet flue gas composition to scrubber B(the one tested) and A, as well as evaluating boiler emissions through both scrubber systems(this includes a retest of boiler 3 through the scrubber).

REFERENCES

1. "Standards of Performance for New Stationary Sources," Title 40, Part 60, Code of Federal Regulations, July 1, 1986.
2. Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III, Stationary Source Specific Methods, U.S. Environmental Protection Agency, EPA-600/4-77-027-b, Research Triangle Park, North Carolina, December 1984.
3. Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators. U.S. Environmental Protection Agency, EPA-340/1-85-018, Research Triangle Park, North Carolina, May 1987.
4. Booth, B.B. "Stack-Pack." Shasta County Air Quality Management District, Redding CA

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APPENDIX A

Personnel Information

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1. USAFOEHL Test Team

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APPENDIX B

State Regulations

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(B) When the owner or operator elects under Section 8(a) [325 IAC 3-2-8(1)] of this Rule to measure carbon dioxide in the flue gases, the measurement of the pollutant concentration and the carbon dioxide concentration shall each be on a consistent basis (wet or dry) and the following conversion procedure used;

$$E = CF_c \frac{(100)}{(\% \text{ CO}_2)}$$

(C) When the owner or operator elects under Section 8(a) [325 IAC 3-1-8(1)] of this Rule to measure sulfur dioxide or nitrogen oxides in the flue gases, the measurement of the pollutant concentration and the sulfur dioxide and/or the nitrogen oxides concentration(s) shall each be on a wet basis and the following conversion procedure used except where wet scrubbers are employed or where moisture is otherwise added to the stack gases;

$$E = C_w F_w \frac{(20.9)}{(20.9 (1 - B_w) - \% \text{O}_{2w})} \quad (20.9)$$

(D) When the owner or operator elects under Section 8(a) [325 IAC 3-1-8(1)] of this Rule to measure sulfur dioxide or nitrogen oxides in the flue gases, the measurement of the pollutant concentration and the sulfur dioxide and/or the nitrogen oxides concentrations(s) shall each be on a wet basis and the following conversion procedure used where wet scrubbers or moisture is otherwise present in the stack gases provided water vapor content of the stack gas is measured at least once every fifteen minutes at the same point as the pollutant and oxygen measurements are made;

$$E = C_w F \frac{(20.9)}{(20.9 (1 - B_w) - \% \text{O}_{2w})} \quad (20.9)$$

(E) The values used in the equations under this Section are derived as follows: C_w = pollutant concentration at stack conditions, g/wscm (grams/wet standard cubic meter), lb/wscm (pounds/wet standard cubic meter), determined by multiplying the average concentration (ppm) for each one hour period by 4.15×10^{-5} Mg/wscm per ppm (2.59×10^{-5} M lb/wscm per ppm) where M is pollutant molecular weight, g/g-mole (lb/lb-mole).

M = 64.07 for sulfur dioxide and 46.01 for nitrogen oxides.

C = as above but measured in terms of pounds/dry standard cubic meter (lb/dscm) or grams/dry standard cubic meter (g/dscm).

F_c = a factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted (F), and a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the fuel combusted (F_c), respectively. Values of F and F_c are given in Section 60.45(f) of 40 CFR Part 60, as applicable.

F_w = a factor representing a ratio of the volume of wet flue gases generated to the calorific value of the fuel combusted. Values of F_w are:

(i) For anthracite coal as classified according to A.S.T.M. D388-66, F_w = 1.188 wscm/million calories (10580 wscf/million BTU).

(ii) For sub-bituminous and bituminous coal as classified according to A.S.T.M. D388-66, F_w = 1.200 wscm/million calories (10680 wscf BTU).

(iii) For liquid fossil fuels including crude, residual, and distillate oils, F_w = 1.164 wscm/million calories (10360 wscf/million BTU).

(iv) For gaseous fossil fuels: for natural gas, F_w = 1.196 wscm/million calories (10650 wscf/million BTU); for propane, F_w = 1.150 wscm/million calories (10240 wscf/million BTU); for butane F_w = 1.172 wscm/million calories (10430 wscf/million BTU).

B_w = proportion by volume of water vapor in the ambient air.

B_w = proportion by volume of water vapor in the stack gas.

$\% \text{O}_2$, $\% \text{CO}_2$ = Oxygen or carbon dioxide volume (expressed as percent) determined with equipment specified under Section 8 [325 IAC 3-1-8] of this Rule.

E = pollutant emission, lb/million BTU.

(2) For sulfuric acid plants the owner or operator shall:

(A) Establish a conversion factor three times daily according to the procedures of Section 60.84(b) of 40 CFR Part 60;

(B) Multiply the conversion factor by the average sulfur dioxide concentration in the flue gases to obtain average sulfur dioxide emissions in lb/ton; and

(C) Report the average sulfur dioxide emission for each 3-hour period in excess of the emission standard set forth in 325 IAC 7-1 (formerly known as APC-13), in the quarterly summary.

(3) For nitric acid plants the owner or operator shall:

(A) Establish a conversion factor according to the procedures of Section 60.73(b) of 40 CFR Part 60;

(B) Multiply the conversion factor by the average nitrogen oxides concentration in the flue gases to obtain nitrogen oxides emissions in lb/ton;

(C) Report the average nitrogen oxides for each averaging period in excess of the emission standard set forth in 325 IAC 10-1 (formerly known as APC-17), in the quarterly summary.

(4) Alternate Data Reporting and Reduction Procedures.

(A) Alternate procedures for computing emission averages that do not require integration of data may be approved by the APCB if the owner or operator shows that his procedures are at least as accurate as those in this Rule [325 IAC 3-1].

(B) Alternative methods of converting pollutant concentration measurements to units of the emission standard may be approved by the APCB if the owner or operator shows that his procedures are at least as accurate as those in this Rule [325 IAC 3-1].

Rule 2. Source Sampling Procedures

Sec. 1. Applicability. this rule applies to any emissions testing performed in the State to determine compliance with applicable emission limits contained in this Title (Air Pollution Control Board Rules), or for any other purpose requiring review and approval by the APCB.

Sec. 2. Adoption of Federal Test Procedures. Emissions tests subject to this Rule shall be conducted in accordance with the procedures and analysis methods specified in Title 40, Code of Federal Regulations Part 60, Appendix A and Part 61 Appendix B, as in effect on December 2, 1981. Such test methods, equipment, calibration requirements, and analysis must be strictly followed unless otherwise approved by the Board or the Technical Secretary. If any test method is

revised as contained in the Code of Federal Regulations, this Rule is subject to change pursuant to IC 4-22-2.

Sec. 3. Requirements Prior to Conducting Tests. (a) When a test is to be performed by any person other than staff, a test protocol form shall be completed and received by the Board no later than 35 days prior to the intended test date. Such test protocol shall be on a form approved by the Board. Any special or unique information relative to the scheduled test shall be included with the form.

(b) After evaluating the completed test protocol form, the Board or the Technical Secretary.

(1) Inspect the test site.

(2) Require additional conditions, including, but not limited to the following:

(A) Reasonable modifications to the stack or duct to obtain acceptable test conditions.

(B) A pretest meeting to resolve an acceptable test protocol.

(C) Additional tests to allow for adverse conditions such as interferences, non-steady or cyclic processes.

(D) The keeping of process operating parameter records, operating logs or charts during the test.

(E) Conditions on control equipment operation to make it representative of future normal operation, or

(F) The recording of specified control equipment operating parameters during the test.

(c) If the Board or the Technical Secretary requires modifications to the test methods, analytical methods, operational parameters or other matters included in the test protocol, or if a pretest meeting is required, the source operator and the testing firm shall be notified by letter or telephone at least 25 days prior to the proposed test date. The source operator will receive notice of the acceptability of the test protocol from the Board or the Technical Secretary within 10 days of its receipt. If the source operator or test firm desires to change any previously submitted procedures or conditions, the Board must be notified of such change at least 25 days prior to the intended test date, and such changes cannot be made unless approved by the Board or the Technical Secretary prior to the test. Changes in the test protocol that result from emergency conditions

must be approved by an authorized on-site staff member.

(d) The Board or the Technical Secretary reserves the right to conduct any portion of the reference method tests. In such case, a 25-day notice of proper test procedures will be given to the company and their testing representative.

(e) The source operator must notify the Board of the actual test date at least two weeks prior to the date.

Sec. 4. Performance of Test. (a) Staff may observe the field test procedures and plant operation during the test.

(b) All tests shall be conducted while the source is operating at between 95% to 100% of its maximum operating capacity, or under other capacities or conditions specified and approved by the Board or the Technical Secretary. For the purpose of this rule, maximum operating capacity means the maximum design capacity of the source or other maximum operating capacities agreed to by the source and the Board or the Technical Secretary.

(c) Sources subject to Article 12 of this Title (New Source Performance Standards) shall be tested under conditions as specified in the applicable Rule.

(d) Calibration results of the various sampling components must be available for examination at the test site. The information must include dates, methods used, data and results. All components requiring calibration must be calibrated within 60 days prior to the actual test date. Post test calibrations must be performed on the components within 45 days after the actual test date or before the equipments' next field use whichever comes first. Components requiring calibration are listed in the Federal test methods specified in Section 2 above. Calibration need not be done between tests when several facilities at one location are tested in series, as long as the units are calibrated prior to the first test and after the last test in the series which is conducted at that site.

Sec. 5. Test Results and Reports. (a) All tests shall be reported to the Board or the Technical Secretary in the form of a test report containing the following information (which can be kept confidential upon request):

(1) Certification by team leader and reviewer.

(2) Introduction, containing:

(A) Date and type of tests,
(B) Type of process and control equipment,

(C) Plant name and location,

(D) Purpose of test, and

(E) Test participants and titles.

(3) Results summary, containing:

(A) Tabulated data and results of each test run, process weight rate or heat input rate, the stack gas flow rate, the measured emissions given in units consistent with the applicable emission limits, and the visible emissions or average opacity readings, and
(B) Allowable emission rate.

(4) Process information, including:

(A) Description of process and control device,

(B) Process flow diagram,

(C) Maximum design capacities,

(D) Fuel analysis and heat value for heat input rate determination,

(E) Process and control equipment operating conditions during tests,

(F) Discussion of variations from normal plant operations, and

(G) Stack height, exit diameter, volumetric flow rate (acfm), exit temperature, and exit velocity.

(5) Sampling information, including:

(A) Description of sampling methods used,

(B) Brief discussion of the analytical procedures with justification for any variance from standard procedures.

(C) Specification of the number of sampling points, time per point, and total sampling time per run,

(D) Cross sectional diagram showing sampling points, diagram showing stack dimensions, sampling location and distance from the nearest flow disturbance upstream and downstream of the sampling points, and

(E) Sampling train diagram.

(6) Appendix, containing:

(A) Sampling and analytical procedures
(B) Results and calculations — One complete calculation using actual data for each type of test performed must be shown. Results must be stated to units consistent with the applicable emission limitation.

(C) Raw production data signed by plant official.

(D) Photocopies of all actual field data or original raw field data.

(E) Laboratory report with chain of custody shown.

(F) Copies of all calibration data.

(G) Applicable regulations showing emission limitation, and

(H) Copies of visible emissions observations or opacity monitor readings (for TSP tests).

(b) Unless previously agreed to in writing by the Board or the Technical Secretary, all test reports must be received by the Board within forty-five (45) days of the completion of the testing.

Sec. 6. Special Requirements for Testing Certain Pollutants. (a) Particulate matter tests shall be conducted in accordance with the following procedures:

(1) Method 5, Title 40 Code of Federal Regulations, Part 60, Appendix A, as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) Visible emissions (VE) evaluation shall be performed in conjunction with a particulate emissions test by a qualified observer in accordance with the procedures contained in 325 IAC 5-1-4. VE readings shall be continuously recorded for at least 30 minutes per hour of sampling time for each sampling repetition. A variance from this requirement may be granted by the on-site staff person for one repetition only and provided that adverse conditions exist which would invalidate the VE readings. Sources equipped with continuous opacity monitors may submit the monitor's instantaneous or six-minute integrated readings during the sampling period, in lieu of performing VE observations; provided,

(A) The monitoring system meets the Performance Specifications Tests I as specified in 40 CFR 60, Appendix B as in effect on December 2, 1981, and

(B) The monitor readings submitted with the test include a zero and span calibration check at the start and end of each test.

(3) At least three (3) repetitions of the test must be performed under identical source operating conditions unless otherwise allowed by the Board or the Technical Secretary.

(4) During each of the repetitions, each sampling point shall be sampled for a minimum of two (2) minutes.

(5) The total test time per repetition shall be no less than sixty (60) minutes.

(6) The total sample volume per repetition shall be no less than thirty (30) dry standard cubic feet (dscf).

(7) The total particulate weight collected from the sampling nozzle, probe, cyclone (if used), filter holder (front half), filter and connecting glassware shall be reported. Particulate analysis of the impinger catch is not required unless specified by staff.

(b) Sulfur dioxide (SO₂) tests shall be conducted in accordance with the following procedures:

(1) Method 6 or Method 8, Title 40 Code of Federal Regulations, Part 60, Appendix A, as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) At least three (3) repetitions of two (2) samples, each of Method 6 or three (3) repetitions of Method 8 performed under identical source operating conditions, shall constitute a test.

(3) During each of the repetitions for Method 8, each sampling point shall be sampled for a minimum of two (2) minutes.

(4) The total test time per repetition shall be as follows:

(A) Method 6 — a minimum of 20 minutes per run with a 30 minute interval between each run, or

(B) Method 8 — a minimum of 60 minutes per run.

(5) The total sample volume per repetition under Method 8 shall be no less than 40 dry standard cubic feet (dscf).

(c) Nitrogen oxide tests shall be conducted in accordance with the following procedures:

(1) Method 7, Title 40, Code of Federal Regulations, Part 60, Appendix A as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) At least three (3) repetitions of four (4) samples each shall constitute a test.

(d) Volatile Organic Compounds (VOC) emissions tests shall be conducted in accordance with the following procedures:

(1) Method 25, Title 40 Code of the Federal Regulations, Part 60, Appendix A as in effect on December 2, 1981, or other procedures approved by the Board or duly authorized staff member shall be used for

the total non-methane organic (TNMO) emissions.

(2) At least three (3) duplicate samples must be collected and analyzed.

(3) The total test time per repetition shall be a minimum of sixty (60) minutes.

Sec. 7. Invalid Tests. Any tests not meeting the requirements of this Rule may be treated by staff and the Board as invalid for any and all purposes.

Sec. 8. Board Resolves Disputes. A source operator or testing firm may appeal to the Board any decision made by staff under the discretionary terms of this Rule. Any person desiring to make such an appeal shall notify staff of the matters to be appealed, and, if agreement cannot be reached, the matter shall be presented to the Board for a final determination. The Board may appoint one of its members to hear the matter and make recommendations for a final decision by the full Board.

ARTICLE 4. BURNING REGULATIONS

Rule 1. Open Burning

Sec. 1. Applicability—This Rule [325 IAC 4-1-] establishes standards for the open burning of material which would result in emissions of regulated pollutants and applies everywhere in the State. However, this Rule [325 IAC 4-1-] shall not apply in areas where acts permitted by Section 3 [325 IAC 4-1-3] or authorized by variance pursuant to Section 4 [325 IAC 4-1-4] are prohibited by other State and/or local laws, regulations, or ordinances such as IC 13-7-4-1(g).

Sec. 2. Prohibition—No persons shall open burn any material except as provided in Section 3 [325 IAC 4-1-3] or Section 4 [325 IAC 4-1-4].

Sec. 3. Exemptions. (a) The following types of fires are permitted:

(1) Fires celebrating Twelfth Night Ceremonies.

(2) Fires celebrating school pep rallies.

(3) Fires celebrating scouting activities.

(4) Camp fires.

(5) Residential burning—where residence contains four or fewer units. Burning shall be in a noncombustible container with enclosed sides a bottom, and a mesh covering with openings no larger than 1/4" square. Burning is prohibited in apartment complexes and mobile home parks.

(6) Farm burning—wood products derived from farming operations. Clearing operations (Section 4(a)(4) [325 IAC 4-1-4(a)(4)]) are not considered farm burning.

(7) Waste oil burning—where the waste oil has been collected in a properly constructed and located pit as prescribed in 310 IAC 7-1-37(A) (Rule 37A of the Division of Oil and Gas, Department of Natural Resources) at an oil well. Each oil pit may be burned once every two (2) months and all the oil must be completely burned within thirty (30) minutes after ignition.

(b) All exemptions shall be subject to the following:

(1) Only wood products shall be burned unless otherwise stated above.

(2) Fires shall be attended at all times until completely extinguished.

(3) If fires create an air pollution problem, a nuisance, or a fire hazard, they shall be extinguished.

(4) All residential, farm operation, and waste oil burning shall occur during daylight hours during which the fires may be replenished, but only in such a manner that nearly all of the burning material is consumed by sunset.

(5) No burning shall be conducted during unfavorable meteorological conditions such as temperature inversions, high winds, air stagnation, etc.

Sec. 4. Variances. (a) Burning with prior approval of the board or its designated agent may be authorized for the following:

(1) Emergency burning of petroleum products.

(2) Burning of refuse consisting of material resulting from a natural disaster.

(3) Burning for the purpose of fire training.

(4) Burning of natural growth derived from a clearing operation, i.e., removal of natural growth for change in use of the land.

(5) Burning of highly explosive or other dangerous materials.

(b) Burning not exempted by Section 3 [325 IAC 4-1-3] may be permitted with prior receipt of a variance application and approval of the Board. (*Air Pollution Control Board*)

Sec. 5. Liability—Any person who allows the accumulation or existence of

combustible material which constitutes or contributes to a fire causing air pollution shall not be excused from responsibility therefore on the basis that said fire was accidental or an act of God.

Rule 2. Incinerator

Sec. 1. Applicability—This Rule [325 IAC 4-2] establishes standards for the use of incinerators which emit regulated pollutants. This rule [325 IAC 4-2] does not apply to incinerators in residential units consisting of four or fewer families. All other incinerators are subject to this rule. [325 IAC 4-2].

Sec. 2. Stationary Incinerators—All stationary incinerators shall:

(1) Consist of primary and secondary chambers or the equivalent.

(2) Be equipped with a primary burner unless burning wood products.

(3) Comply with 325 IAC 5-1 (formerly known as APC 3) and 325 IAC Article 2 (formerly known as APC 19).

(4) Be maintained properly as specified by the manufacturer and approved by the Board or its designated agent.

(5) Be operated according to the manufacturer's recommendations and only burn waste approved by the Board or its designated agent.

(6) Comply with other state and/or local regulations or ordinances regarding installation and operation.

(7) Be operated so emissions of hazardous material including, but not limited to, viable pathogenic bacteria, dangerous chemicals or gases, or noxious odors are prevented

(8) Not emit particulate matter in excess of the following:

(A) Incinerators with a maximum refuse-burning capacity of 200 or more pounds per hour: 0.3 pounds of particulate matter per 1,000 pounds of dry exhaust gas at standard conditions as corrected to 50% excess air.

(B) All other incinerators: 0.5 pounds of particulate matter per 1,000 pounds of dry exhaust gas at standard conditions corrected to 50% excess air.

(9) Not create an air pollution problem, a nuisance or a fire hazard. If any of the above result, the burning shall be terminated immediately

Sec. 3. Portable Incinerators—All portable incinerators shall be subject to the following conditions:

(1) Approval of the Board or its designated agent must be obtained prior to operation at a new project site.

(2) Only wood products shall be burned.

(3) Merchantable material shall be salvaged where practicable.

(4) The local health department shall be notified prior to any burning.

(5) All burning shall be conducted under favorable meteorological conditions.

(6) Burning shall occur during daylight hours and all material shall be consumed by sunset.

(7) If burning creates an air pollution problem, a nuisance or a fire hazard, the burning shall be terminated immediately.

(8) The incinerator shall be maintained and operated according to the manufacturer's recommendations and in a manner approved by the Board or its designated agent.

(9) The installation and operation of such an apparatus shall comply with all other state and/or local regulations or ordinances.

(10) A portable incinerator shall comply with both 325 IAC 5-1 (formerly known as APC 3) and 325 IAC, Article 2 (formerly known as APC 19).

ARTICLE 5. OPACITY REGULATIONS

Rule 1. Opacity Limitations

Sec. 1. Applicability. (a) This rule [325 IAC 5-1] shall apply to all visible emissions (not including condensed water vapor) emitted by or from any facility or source except those sources or facilities for which specific visible emission limitations are established by 325 IAC, Article 11, 325 IAC, Article 12, or 325 IAC, Article 6.

(1) The requirements of Section 2(a)(1) [325 IAC 5-1-2(a)(1)] shall apply to sources or facilities located in attainment areas for particulate matter, designated in 325 IAC 1.1-3 (formerly known as APC 22).

(2) The requirements of Section 2(a)(2) [325 IAC 5-1-2(a)(2)] shall apply to sources or facilities located in nonattainment areas for particulate matter as designated in 325 IAC 1.1-3 (formerly known as APC 22).

(b) Sources or facilities located in areas

designated as unclassifiable or attainment areas in 325 IAC 1.1-3 (formerly Regulation APC 22) which became subject to more stringent limitations as a result of said area being redesignated as a nonattainment area by the Board, shall comply with such limitations as expeditiously as practicable, but no later than December 31, 1982. No later than 60 days after the promulgation of the nonattainment designation in 325 IAC 1.1-3, all sources or facilities subjected to more stringent visible emission limitations by their redesignation shall submit to the Board for approval a schedule for attaining compliance with this Rule [325 IAC 5-1].

Sec. 2. Emission Limitations. (a) Visible emissions from any source or facility shall not exceed any of the following limitations. Unless otherwise stated, all visible emissions shall be observed in accordance with the procedures set forth in Section 4 [325 IAC 5-1-4] of this rule:

(1) Sources or facilities of visible emissions located in attainment areas for particulate matter shall meet the following limitations:

(A) Visible emissions shall not exceed, an average of 40% opacity in 24 consecutive readings.

(B) Visible emissions shall not exceed 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

(2) Sources or facilities of visible emissions located in nonattainment areas shall meet the following limitations:

(A) Visible emissions shall not exceed, an average of 30% opacity in 24 readings.

(B) Visible emissions shall not exceed 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

(3) Sources and facilities of visible emissions located in both attainment or nonattainment areas, for which an alternate visible emission limitation has been established pursuant to Section 5(b) [325 IAC 5-1-5(b)] herein, shall comply with said limitations in lieu of the limitations set forth in subsection 2(a)(1) and 2(a)(2) [subsections (a)(1) and (a)(2) of this section] preceding.

Sec. 3. Temporary Exemptions. (a) Boiler Startup and Shutdown—When building a new fire in a boiler, or shutting down a boiler, visible emissions may ex-

ceed the applicable opacity limit established in Section 2(a) [325 IAC 5-1-2(a)]; however, visible emissions shall not exceed an average of 60% opacity and emissions in excess of the applicable opacity limit shall not continue for more than 10 continuous minutes on one occasion in any 24-hour period.

(b) Cleaning Boilers—When removing ashes from the fuel bed or furnace in a boiler or blowing tubes, visible emissions may exceed the applicable opacity limit established in Section 2(a) [325 IAC 5-1-2(a)]; however, visible emissions shall not exceed 60% opacity and visible emissions in excess of the applicable opacity limit shall not continue for more than five continuous minutes on one occasion in any 60-minute period. Such emissions shall not be permitted on more than three occasions in any 12-hour period.

(c) Facilities not temporarily exempted by Subsections (a) and (b) above may be granted special temporary exemptions by the Board of the same duration and type authorized therein provided that the facility proves to the satisfaction of the Board that said exemptions are needed and that during periods of startup and shutdown, owners and operators shall, to the extent practicable, maintain and operate any affected facility including air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Board, which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures and inspection of the source.

(d) Sources or facilities not exempted through subsections (a), (b), or (c) above may also be granted special exemptions by the Board, provided that the source or facility owner or operator proves to the satisfaction of the Board that said exemption is justifiable. Said exemption(s) may be of longer duration and may apply to other types of facilities not provided for in subsections (a) and (b) above.

Sec. 4. Procedure to Determine Compliance. (a) Determination of visible emissions from sources or facilities to which this Rule [325 IAC 5-1] applies may be

made in accordance with subsections (1) and (2) below.

(1) Determination of visible emissions by means of a qualified observer shall be made according to the following provisions (A) through (H).

(A) Position—The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun, if visible, oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from the position such that his line of vision is approximately perpendicular to the direction of the visible emissions (plume where applicable), and when observing opacity of emissions from rectangular outlets (e.g., monitors open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

(B) Field Records—The observer shall record the name of the plant, emission location, type of facility, observer's name and affiliation, and the date on a field data sheet. Time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky conditions (presence and color of clouds), and visible emissions (plume where applicable) background are recorded on a field data sheet at the time opacity readings are initiated and completed.

(C) Observations—Opacity observations shall be made at the point of greatest opacity in that portion of the visible emissions, (plume where applicable) where condensed water vapor is not present. The observer shall not look continuously at the visible emissions, (plume where applicable) but instead shall observe the visible emissions, (plume where applicable) momentarily at 15-second intervals.

(D) Recording Observations—Opacity observations shall be recorded to the nearest 5% at 15-second intervals on an observational record sheet. A minimum of 24 observations shall be recorded. Each

momentary observation shall be deemed to represent the average opacity of emissions for a 15-second period.

(E) Determination of Opacity As An Average of 24 Consecutive Observations—Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. Record the average opacity on a record sheet. For the purpose of determining an alternative visible emission limit in accordance with Section 5(b) [325 IAC 5-5-5(b)] following, an average of 24 consecutive readings or more may be used to calculate the alternate visible emissions limit.

(F) Determination of Opacity As A Cumulative Total of 15 Minutes—For emissions from intermittent sources, opacity shall be determined in accordance with subsections (1), (2), (3), and the first sentence of (4). Each momentary observation shall be deemed to represent the average opacity of emissions for a 15 second period. All readings greater than the specified limit in Section 2 [325 IAC 5-1-2] shall be accumulated as 15 second segments for comparison with the limit.

(G) Attached Steam Plumes—When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

(H) Detached Steam Plumes—When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet prior to the condensation of water vapor and the formation of the steam plume.

(2) Determination of compliance with visible emission limitations established in this Rule [325 IAC 5-1] may also be made

in accordance with a source's or facility's continuous monitoring equipment, for any source or facility in compliance with the requirements of 325 IAC 3-1.

(b) If the compliance determination procedures set forth in subsection (1) and (2) preceding results in any conflict in visible emission readings, the determination made in accordance with subsection (2) above shall prevail for the purpose of compliance, provided that it can be shown that the continuous monitor has met the performance specifications as set forth in the U.S. EPA Federal Reference 40 CFR, Part 60, specifically Performance Specification 1.

Sec. 5. Special Considerations. (a) A violation of this Rule [325 IAC 5-1] shall constitute prima facie evidence of a violation of other applicable particulate emission control regulations. A violation of any such regulation can be refuted by a performance test conducted in accordance with paragraph (b), below. Such test shall refute the mass emission violation only if the source is shown to be in compliance with the allowable mass emission limit. An exceedance of the allowable opacity emission limit will not be treated as a violation if, during the test described in (b) below, the source demonstrates compliance with the allowable mass emission limit while simultaneously having visible emissions more than or equal to the reading at which the exceedance was originally observed.

(b) Establishment or Alternate Visible Emission Limits—The owner or operator of a source or facility which believes it can operate in compliance with the applicable mass emission limitation, but exceeds the limits specified in Section 2 [325 IAC 5-1-2] of this Rule, may submit a written petition to the Technical Secretary requesting that an alternate opacity limitation be established pursuant to the following provisions. Additionally, if the Board has issued a Notice of Violation to an owner or operator of a source or facility for violation of the applicable opacity limitation, such owner or operator may, propose in Notice of Violation resolution, to disprove said violation by establishing an alternate opacity limit pursuant to the following provisions. This alternate limit shall be based upon a mass emission performance test conducted according to a

method designated by the Board, and a visible emission test conducted simultaneously, according to Section 4 [325 IC 5-1-4] of this Rule. Where the Board determines there is no acceptable test method available, a request for an alternate visible emission limit shall be denied.

(1) The alternate emission limit shall be equal to that level of opacity at which the source or facility will be able, as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation. However, the Board shall also reserve the right to determine the alternate visible emissions limit in the following manner:

(A) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emissions limit (as defined in 325 IAC 1.1.-1) at the time that the test is done, and; (ii) simultaneously, said source's or facility's test demonstrates that the allowable opacity emission limit is being exceeded, then, the enforceable opacity limitation shall be equal to that level of opacity at which the source or facility will be able as indicated by the performance and opacity tests to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation.

(B) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emission limit, and the test mass emission rate is within 10% of the allowable emissions limit for that source or facility, and; (ii) simultaneously, said source's or facility's test demonstrates that the opacity observed is below the allowable opacity emission limit, the enforceable opacity limitation shall be equal to that level of opacity at which the source or facility will be able as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation.

(C) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emission limit, and the test mass emission rate is less than 90% of the allowable emissions limit and; (ii)

simultaneously, said source's or facility's test demonstrates that the opacity observed is below the allowable opacity emission limit, the enforceable opacity limitation shall remain the existing allowable opacity emission limitation for that source or facility.

(2) Compliance with 325 IAC 6-2 (formerly known as APC 4R), 325 IAC 6-3 (formerly known as APC 5), 325 IAC 11-1 (formerly known as APC 6), and 325 IAC 6-1 (formerly known as APC 23), and other applicable regulations must be demonstrated by the performance test.

(3) The Board may require a performance test in any case where it is necessary to determine the compliance status for a facility. However, the Board will not request a performance test for any facility which is known to be in compliance with the allowable opacity limitation.

(4) All alternate visible emission limits shall be established on a source or facility-specific basis. No limitation for any facility or source shall be established by reference to a similar or identical facility or source.

(5) The owner or operator of the source or facility shall notify the Board at least fifteen days prior to conducting a test for the purposes of demonstrating an alternate visible emission limit.

(6) A staff member who is a qualified observer, approved by the Board or other consultant approved by the Board shall be present during any performance tests.

(7) The cost of the performance test shall be at the expense of the owner or operator.

(8) Any alternate visible emission limit established for any source or facility shall not become effective until said limitation is established in the applicable operating permit. Said limitation will be incorporated, by amendment, into the operating permit for said source or facility and submitted to the U.S. EPA as a SIP revision.

(9) Where a visible emission limitation is based upon a New Source Performance Standard, any new limitation must comply with the provisions of said standard.

Sec. 6. Compliance Timetables—Sources newly subject to more stringent limitations at the promulgation date of this Rule [325 IAC 5-1] by Section 2 [325 IAC 5-2-1] shall comply with the compliance schedule of 325 IAC 6-1 (formerly known as APC 23).

Sec. 7. SIP Revision—Any exemptions given or provisions granted to this rule [325 IAC 5-1] by the Board in Sections 3 (c) [325 IAC 5-3-2(c)] or 5(b) [325 IAC 5-1-5(b)] shall be submitted to the U.S. EPA as revisions to the State Implementation Plan.

ARTICLE 6. PARTICULATE REGULATIONS

Rule 1. Nonattainment Area Limitations

Sec. 1. Applicability. Sources or facilities specifically listed in Appendix A [325 IAC 6-1-7] of this Rule shall comply with the limitations contained therein. Sources or facilities that are (1) located in the non-attainment counties listed in Appendix A [325 IAC 6-1-7], (2) but which sources or facilities are not specifically listed in Appendix A [325 IAC 6-1-7], and (3) have the potential to emit 100 tons or more of particulate matter per year or have actual emissions of 10 tons or more of particulate matter per year, shall comply with the limitations of Section 2 [325 IAC 6-1-2], hereof.

Sec. 2. Emission Limitations. (a) **General Sources**—Facilities not limited by paragraphs (b) through (g) below shall not allow or permit discharge to the atmosphere any gases which contain particulate matter in excess of 0.07 gram per dry standard cubic meter (g/dscm) (0.03 grain per dry standard cubic foot (dscf)). Where this limitation is more stringent than the applicable limitations of paragraphs (b) through (g) of this section, for facilities in existence prior to the applicability dates, or of a size not applicable to said paragraphs, emission limitations for those facilities shall be determined by the Board and will be established in accordance with the procedures set forth in paragraph (h) of this section.

(b) **Fuel Combustion Steam Generators**—No person shall operate a fossil fuel combustion steam generator (any furnace or boiler used in the process of burning solid, liquid, or gaseous fuel or any combination thereof for the purpose of producing steam by heat transfer) so as to discharge or cause to be discharged any gases unless such gases are limited to:

(1) A particulate matter content of no greater than 0.18 grams per million calo-

ries (0.10 pounds per million Btu) for solid fuel fired generators of greater than 63 million kilocalories (kcal) per hour heat input (250 million Btu);

(2) A particulate matter content of no greater than 0.63 grams per million calories (0.35 pounds per million Btu) for solid fuel fired generators of equal to or greater than 6.3 but less than or equal to 63 million kcal per hour heat input (25 but less than or equal to 250 million Btu);

(3) A particulate matter content of no greater than 1.08 grams per million calories (0.6 pounds per million Btu) for solid fuel fired generators of less than 6.3 million kcal per hour heat input (25 million Btu);

(4) A particulate matter content of no greater than 0.27 grams per million kcal (0.15 pounds per million Btu) for all liquid fuel fired steam generators.

(5) A particulate matter content of no greater than .01 grains per dry standard cubic foot for all gaseous fuel-fired steam generators.

(c) **Asphalt Concrete Plants**—The requirements of this provision shall apply to any asphalt concrete plant (any facility used to manufacture asphalt concrete by heating and drying aggregate and mixing with asphalt cement). An asphalt concrete plant is deemed to consist only of the following: driers, systems for screening, handling, storing, and weighing hot aggregate; systems for loading, transferring, and storing mineral filler; systems for mixing asphalt concrete; and the loading, transfer, and storage systems associated with emission control systems.

(1) No person shall operate the affected facilities of an asphalt concrete plant which existed on or prior to June 11, 1973, so as to discharge or cause to be discharged into the atmosphere any gases unless such gases are limited to:

(A) A particulate matter content of no greater than 230 mg per dscm (0.10 grain per dscf).

(d) **Grain Elevators**—No person shall operate a grain elevator (a grain elevator is defined as any plant or installation at which grain is unloaded, handled, cleaned, dried, stored or loaded) without meeting the provisions of this Section. Paragraph (1) below shall apply to any grain storage elevator located at any grain processing source which has a permanent

* Rule 2. [Repealed]

Rule 2.1. Particulate Emission Limitations for Sources of Indirect Heating

Sec. 1. Applicability. This rule establishes limitations for sources of indirect heating. (a) Particulate emissions from the combustion of fuel for indirect heating from all facilities located in Lake, Porter, Marion, Boone, Hamilton, Hendricks, Johnson, Morgan, Shelby, and Hancock Counties which were existing and in operation or which received permit to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be limited by section 2 below.

(b) Particulate emissions from the combustion of fuel for indirect heating from all facilities not specified in (a) which were existing and in operation or which received permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be limited by section 3 below.

(c) Particulate emissions from the combustion of fuel for indirect heating from all facilities receiving permits to construct on or after the effective date of this rule (325 IAC 6-2.1) shall be limited by section 4 below.

(d) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with applicable limitations contained in 325 IAC 6-1, then the limitations contained in 325 IAC 6-1 prevail.

(e) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with applicable limitations contained in 325 IAC article 12.1 (New Source Performance Standards) then the limitations contained in 325 IAC article 12.1 prevail.

(f) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with a limitation contained in a facility's construction or operation permit as issued pursuant to 325 IAC article 2 (Permit Review Regulations), then the limitations contained in the source's current permits prevail.

(g) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with a limitation required by 325 IAC article 2 (Permit Review Regulations) to prevent a violation of the Ambient Air Quality Standards set forth in 325 IAC 1.1-3, then the limitations required by 325 IAC article 2 prevail.

(h) The addition of a new facility at a

source does not affect the limitations of the existing facilities unless such changes in the limitations are required by the provisions of 325 IAC article 2 or 325 IAC 6-1.

Sec. 2. Emission limitations for facilities specified in 325 IAC 6-2.1-1(a). (a) Particulate emissions from existing indirect heating facilities located in the specified counties shall be limited by the following equation.

$$Pt = \frac{0.87}{Q^{0.16}}$$

Where:

Pt = Pounds of particulate matter emitted per million Btu (lb/mmBtu) heat input.

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's operation permit application, except when some lower capacity is contained in the facility's operation permit, in which case, the capacity specified in the operation permit shall be used.

For Q less than 10 mmBtu/hr, Pt shall not exceed 0.6.

For Q greater than or equal to 10,000 mmBtu/hr, Pt shall not exceed 0.2. Figure 1 may be used to estimate allowable emissions.

(b) The emission limitations for those indirect heating facilities which were existing and in operation on or before June 8, 1972, shall be calculated using the equation contained in subsection 2(a) where: Q shall reflect the total source capacity on June 8, 1972. The resulting Pt is the emission limitation for each facility existing on that date and will not be affected by the addition of any subsequent facility. The particulate emissions from all of the facilities which were in existence on June 8, 1972, may be allocated in any way among these facilities provided that they will not result in a significantly greater air quality impact level at any receptor than that which would result if the particulate emissions from each of these facilities were limited to Pt; and provided that the emission limitations for each facility are

specified in its operation permit. Significant impact levels are defined in 325 IAC 2-3, section 2(d).

(c) The emission limitations for those indirect heating facilities which began operation after June 8, 1972, and before the effective date of this rule (325 IAC 6-2.1), and those facilities which receive permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be calculated using the equation contained in subsection 2(a) where: Q includes the capacity for the facility in question and the capacities for those facilities which were previously constructed or received prior permits to construct. The limitations for all previously permitted facilities do not change. The Q and Pt for each facility at a source which begins operation or receives a construction permit during this time period will be different.

Sec. 3. (a) Particulate emissions from indirect heating facilities existing and in operation before the effective date of this rule shall be limited by the following equation:

$$Pt = \frac{C X a X h}{76.5 X Q^{0.75} X N^{0.25}}$$

Where:

C = Maximum ground level concentration with respect to distance from the point source at the "critical" wind speed for level terrain. This shall equal 50 micrograms per cubic meter (ug/m³) for a period not to exceed a 60-minute time period.

Pt = Pounds of particulate matter emitted per million Btu heat input (lb/mmBtu).

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's operation permit application, except when some lower capacity is contained in the facility's operation permit; in which case, the capacity specified in the operation permit shall be used.

N = Number of stacks in fuel burning operation.

a = Plume rise factor which is used to make allowance for less than theoretical

plume rise. The value 0.67 shall be used for Q less than or equal to 1,000 mmBtu/hr heat input. The value 0.8 shall be used for Q greater than 1,000 mmBtu/hr heat input.

h = Stack height in feet. If a number of stacks of different heights exist, the average stack height to represent "N" stacks shall be calculated by weighing each stack height with its particulate matter emission rate as follows:

$$h = \frac{\sum_{i=1}^N H_i \times p_a \times Q_i}{\sum_{i=1}^N p_a \times Q_i}$$

Where:

p_a = the actual controlled emission rate in lb/mmBtu using the emission factor from AP-42 or stack test data. Stacks constructed after January 1, 1971, shall be credited with GEP stack height only. GEP stack height shall be calculated as specified in rule 325 IAC 1.1-6.1

(b) The emission limitations for those indirect heating facilities which were existing and in operation on or before June 8, 1972, shall be calculated using the equation contained in subsection 3(a) where: Q , N , and h shall include the parameters for all facilities in operation on June 8, 1972. The resulting P_t is the emission limitation for each facility existing on that date and will not be affected by the addition of any subsequent facility. The particulate emissions from all of the facilities which were in existence on June 8, 1972, may be allocated in any way among these facilities provided that they will not result in a significantly greater air quality impact level at any receptor than that which would result if the particulate emissions from each of these facilities were limited to P_t ; and provided that the emission limitations for each facility are

specified in its operation permit. Significant impact levels are defined in 325 IAC 2-3 section 2(d).

(c) The emission limitations for those indirect heating facilities which began operation after June 8, 1972, and before the effective date of this rule (325 IAC 6-2.1), and those facilities which receive permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be calculated using the equation contained in subsection 3(a) where: Q , N , and h shall include the parameters for the facility in question and for those facilities which were previously constructed or received prior permits to construct. The limitations for all previously permitted facilities do not change. The Q , N , h , and P_t for each facility at a source which begins operation or receives a construction permit during this time period will be different.

(d) Particulate emissions from all facilities used for indirect heating purposes which were existing and in operation on or before June 8, 1972, shall in no case exceed 0.8 lb/mmBtu heat input.

(e) Particulate emissions from any facility used for indirect heating purposes which has 250 mmBtu/hr heat input or less and which began operation after June 8, 1972, shall in no case exceed 0.6 lb/mmBtu heat input.

Sec. 4. Emission limitations for facilities specified in 325 IAC 6-2.1-1(c) (a) Particulate emissions from indirect heating facilities constructed after the effective date of this rule (325 IAC 6-2.1) shall be limited by the following equation:

$$P_t = \frac{1.09}{Q^{0.26}}$$

Where:

P_t = Pounds of particulate matter emitted per million Btu (lb/mmBtu) heat input.

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is

operated or the nameplate capacity, whichever is specified in the facility's permit application, except when some lower capacity is contained in the facility's operation permit; in which case, the capacity specified in the operation permit shall be used.

For Q less than 10 mmBtu/hr, P_t shall not exceed 0.6.

For Q greater than or equal to 10,000 mmBtu/hr, P_t shall not exceed 0.1. Figure 2 may be used to estimate allowable emissions.

(b) As each new indirect heating facility is added to a plant Q will increase. As a result, the emission limitation for each progressively newer facility will be more stringent until the total plant capacity reaches 10,000 mmBtu/hr after which the emission limit for each newer facility will be 0.1 lb/mmBtu heat input. The rated capacities for facilities regulated by article 12.1, New Source Performance Standards, shall be included when calculating Q for subsequent facilities.

Rule 3. Process Operations

Sec. 1. Applicability—This Rule [325 IAC 6-3] establishes emission limitations for particulate emissions from process operations located anywhere in the State. The following processes and their attendant emissions are exempt from this Rule [325 IAC 6-3]:

- (1) Combustion for indirect heating
- (2) Incinerators
- (3) Open burning
- (4) Existing Foundry Cupolas

If any limitation established by this Rule [325 IAC 6-3] is inconsistent with applicable limitations contained in 325 IAC 6-1 (formerly known as APC 23), or contained in 325 IAC, Article 12 (New Source Performance Standards), then the limitation contained herein shall not apply; but the limit in such sections shall apply.

Sec. 2. Emission Limitations. (a) Cement Kilns—No owner or operator of a cement manufacturing operation commencing operation prior to December 6, 1968, equipped with electrostatic

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APPENDIX C

Plant Operating Data

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[illegible]

Boiler #3, Byrnes, Run #2

[illegible]

[illegible]

DAILY STEAM BOILER PLANT OPERATING LOG

1. COMMAND SAC **2. BASE AND LOCATION** GRESSON AFB IN 46971 **3. BUILDING NO. AND NAME** 223 BCMP **4. DATE** 33 NOV 48

TIME	STEAM FLOW (GPM)				FUEL OIL				FUEL WATER FLOW (GPM)				MAKE UP WATER FLOW (GPM)				CONDENSATE TEMP (°F)	FUEL WATER PRESSURE (PSIG)	BUCK DISCH
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4			
0000	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	122	205		
0100	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0200	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0300	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0400	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0500	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0600	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0700	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0800	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
0900	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1000	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1100	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1200	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1300	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1400	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1500	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1600	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1700	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1800	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
1900	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
2000	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122	205			
2100	34500	34500	34500	34500	140	140	140	140	420	420	420	420	122	122	122				

[illegible]

APPENDIX D

Coal Analysis

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CORE LABORATORIES, INC. ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0001
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN NUMBER 4279

{BOLER #3}
{BYPASS
{RUN #1}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	18.75	4.44	---
% ASH	4.30	5.06	5.29
% VOLATILE	28.78	33.85	35.42
% FIXED CARBON	48.17	56.66	59.29
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.80	0.95	0.99
BTU/LB.	11,066	13,015	13,620
MAF BTU/LB.	---	---	14,380
LBS SULFUR/MM BTU	0.72		
LBS WATER/MM BTU	16.94		
LBS ASH/MM BTU	3.89		

ASH SOFTENING TEMP: 2675 DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



CORE LABORATORIES
CORE LABORATORIES, INC.
ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0002
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 1300
{ BOILER # 3 }
{ BYPASS }
{ RUN # 2 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	17.76	4.82	---
% ASH	5.27	6.10	6.41
% VOLATILE	29.42	34.05	35.77
% FIXED CARBON	47.55	55.03	57.82
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.76	0.98	0.92
BTU/LB.	11,162	12,919	13,573
MAF BTU/LB.	---	---	14,501
LBS SULFUR/MM BTU	0.68		
LBS WATER/MM BTU	15.91		
LBS ASH/MM BTU	4.72		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



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EVANSVILLE, IN 47712
(812) 424-2909

17-DEC-87

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0003
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN NUMBER 2284

{
BOILER #3
BYPASS
RUN#3
}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	14.70	4.43	---
% ASH	5.23	5.86	6.13
% VOLATILE	30.69	34.39	35.98
% FIXED CARBON	49.38	55.33	57.89
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.83	0.87
BTU/LB.	11,571	12,964	13,565
MAF BTU/LB.	---	---	14,451
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	12.70		
LBS ASH/MM BTU	4.52		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED:

Kevin J. Weil

KEVIN J. WEIL



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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0002
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 2442

{ BOILER # 3
SCRUBBER
RUN # 1 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.90	5.21	---
% ASH	4.51	5.08	5.36
% VOLATILE	29.69	33.46	35.30
% FIXED CARBON	49.90	56.25	59.34
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.83	0.88
BTU/LB.	11,439	12,893	13,602
MAF BTU/LB.	---	---	14,372
LBS SULFUR/MM BTU	0.65		
LBS WATER/MM BTU	13.90		
LBS ASH/MM BTU	3.94		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



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17-DEC-87

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0001
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN NUMBER 2388

{ BOILER # 3
SCRUBBER
RUN # 2 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.76	3.16	---
% ASH	5.33	6.13	6.33
% VOLATILE	30.79	35.40	36.55
% FIXED CARBON	48.12	55.32	57.12
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.75	0.86	0.89
BTU/LB.	11,409	13,116	13,544
MAF BTU/LB.	---	---	14,458
LBS SULFUR/MM BTU	0.66		
LBS WATER/MM BTU	13.81		
LBS ASH/MM BTU	4.67		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED:

Kevin J. Weil

KEVIN J. WEIL



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ANALYTICAL REPORT

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0001
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #3648

{ BOILER # 3
SCRUBBER
RUN # 3 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.41	3.54	- -
% ASH	5.30	6.04	6.26
% VOLATILE	31.00	35.35	36.65
% FIXED CARBON	48.29	55.07	57.09
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.83	0.86
BTU/LB.	11,474	13,084	13,564
MAF BTU/LB.	---	---	14,469
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	13.43		
LBS ASH/MM BTU	4.62		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



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CORE LABORATORIES, INC.
ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0002
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #3872

{ BOMER #4 }
{ BYPASS }
{ RUN# 1 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	18.97	5.09	---
% ASH	5.65	6.62	6.97
% VOLATILE	29.00	33.97	35.79
% FIXED CARBON	46.38	54.33	57.24
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.97	1.14	1.20
BTU/LB.	10,834	12,689	13,370
MAF BTU/LB.	---	---	14,371
LBS SULFUR/MM BTU	0.90		
LBS WATER/MM BTU	17.51		
LBS ASH/MM BTU	5.21		

ASH SOFTENING TEMP: 2590 DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



CORE LABORATORIES
CORE LABORATORIES, INC.
ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

17-DEC-87

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO.: 0004
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN NUMBER 2448

{ BOILER# 4
BYPASS
RUN# 2 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	16.36	4.80	---
% ASH	5.52	6.28	6.60
% VOLATILE	30.10	34.26	35.99
% FIXED CARBON	48.02	54.65	57.41
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.84	0.88
BTU/LB.	11,302	12,864	13,513
MAF BTU/LB.	---	---	14,467
LBS SULFUR/MM BTU	0.65		
LBS WATER/MM BTU	14.47		
LBS ASH/MM BTU	4.88		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



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ANALYTICAL REPORT

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSB/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO.: 0004
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN NUMBER 29

{ BOILER#4 }
{ BYPASS }
{ RUN#3 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.08	4.95	---
% ASH	5.37	6.01	6.32
% VOLATILE	30.21	33.82	35.58
% FIXED CARBON	49.34	55.22	58.10
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.93	0.87
BTU/LB.	11,464	12,832	13,500
MAF BTU/LB.	---	---	14,410
LBS SULFUR/MM BTU	0.65		
LBS WATER/MM BTU	13.15		
LBS ASH/MM BTU	4.68		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

KEVIN J. WEIL



CORE LABORATORIES
CORE LABORATORIES, INC.
ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0004
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #3035

{ BOWER # 4
SCRUBBER
RUN #1 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	16.66	3.95	---
% ASH	5.33	6.15	6.40
% VOLATILE	29.97	34.54	35.96
% FIXED CARBON	48.04	55.36	57.64
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.85	0.88
BTU/LB.	11,334	13,063	13,600
MAF BTU/LB.	---	---	14,529
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	14.70		
LBS ASH/MM BTU	4.70		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

KEVIN J. WEIL



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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0003
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #4264

{ BOKER #4
SCRUBBER
RUN #2 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	16.47	2.46	---
% ASH	5.23	6.11	6.26
% VOLATILE	30.64	35.78	36.68
% FIXED CARBON	47.66	55.66	57.06
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.71	0.83	0.85
BTU/LB.	11,356	13,261	13,595
MAF BTU/LB.	---	---	14,502
LBS SULFUR/MM BTU	0.63		
LBS WATER/MM BTU	14.50		
LBS ASH/MM BTU	4.61		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL



CORE LABORATORIES
CORE LABORATORIES, INC.
ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0003
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 8624

*Boiler #4
SCRUBBER
RUN #3*

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.19	3.74	---
% ASH	5.44	6.18	6.42
% VOLATILE	30.06	34.11	35.44
% FIXED CARBON	49.31	55.97	58.14
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.83	0.86
BTU/LB.	11,495	13,047	13,554
MAF BTU/LB.	---	---	14,484
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	13.21		
LBS ASH/MM BTU	4.73		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil
KEVIN J. WEIL

APPENDIX E

Boiler 3, Bypass Stack

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S O U R C E T E S T R E P O R T

SOURCE :
 GRISSOM AFB CENTRAL HEATING PLANT
 GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #3:BYPASS STACK

DATE TESTED : 18-20 NOV 87

SUBMITTING AGENCY :
 USAFOEHL/ECQ

BROOKS AFB, TX 78235

DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: BYPASS Stack diameter at ports: 5.5 (ft)

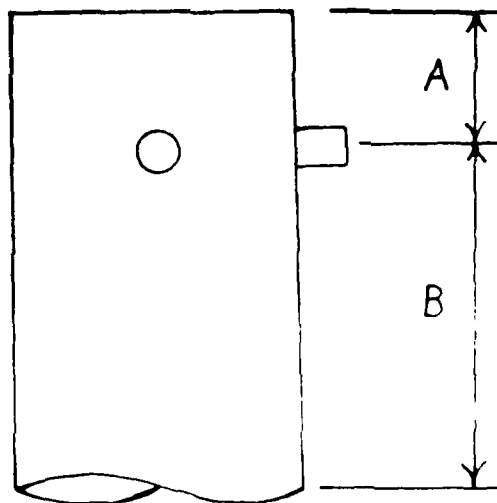
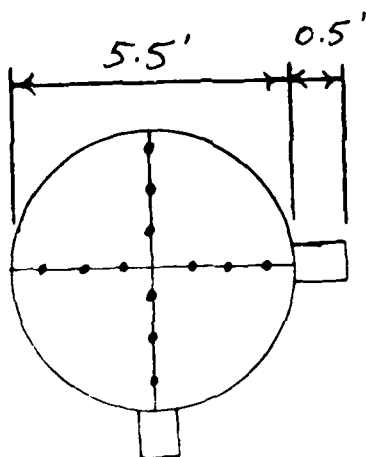
Distance A (ft) 11.5 (duct diameters) 2.1

Recommended number of traverse points as determined by
distance A: 12

Distance B (ft) 39.5 (duct diameters) 7.2

Recommended number of traverse points as determined by
distance B: 12

Number of traverse points used: 12



TEST TRAVERSE POINT LOCATION

STACK DIAM. (IN.) = 66
STACK RADIUS (IN.) = 33
STACK DIAM. (FT.) = 5.5
STACK AREA (SQ.FT) = 23.75828

POINT #	DISTANCE IN.
1	2.875261
2	9.665478
3	19.52781
4	46.4722
5	56.33452
6	63.12474

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5 PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD.TEMP (F) = 68
STD.TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

***** RUN # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 279.2611

AMBIENT WET BULB (K) = 276.4833

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 31.467 DEG. F.

VAPOR PRESSURE (IN.HG) = .1766514

SATURATION VAPOR PRESS. (IN.HG) = .2770307

RELATIVE HUMIDITY (%) = 63.76599

SPECIFIC HUMIDITY (pp1000) = 3.792975

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12

AMBIENT PRESS. (IN.HG) = 29.42

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	47	47	47	1.88
2	49	47	48	1.69
3	53	48	50.5	2.08
4	56	49	52.5	1.9
5	57	50	53.5	1.33
6	57	50	53.5	1.52
7	51	51	51	1.13
8	50	50	50	1.32
9	52	50	51	1.7
10	55	50	52.5	2.09
11	57	51	54	2.28
12	58	51	54.5	1.71

FINAL AVG. METER TEMP (R) = 511.5

DELTA H₀ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 29.54641

H 2 O T E S T D A T A

START METER READING = 41.3
END METER READING = 77.093
TOTAL CONDENSATE VOL (ML) = 50.08
H2O VAPOR GAS VOLUME @ STP = 2.373792
TOTAL METER GAS VOL (uncorrected CF) = 35.793
AVG. METER TEMP (R) = 511.5
TOTAL DRY SAMPLE VOL (CF @ STP) = 36.48628
MOLE FRACTION DRY AIR = .9389143
% H2O BY VOL = 6.108565

G A S D E N S I T Y

% CO2 = 10.17
% O2 = 9.37
% CO = 0
% N2 = 78

GAS DENSITY = .9886743

DRY MOL. WT. = 29.3132

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.42
STACK PRESS (IN.HG) = 29.4237
TEST START TIME = 1437

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .05	880 / 507	16.38736	1.88	5
2 / .045	880 / 508	15.54642	1.69	5
3 / .055	880 / 510.5	17.18721	2.08	5
4 / .05	880 / 512.5	16.38736	1.9	5
5 / .035	880 / 513.5	13.71065	1.33	5
6 / .04	880 / 513.5	14.6573	1.52	5
7 / .03	880 / 511	12.6936	1.13	5
8 / .035	880 / 510	13.71065	1.32	5
9 / .045	880 / 511	15.54642	1.7	5
10 / .055	880 / 512.5	17.18721	2.09	5
11 / .06	880 / 514	17.95146	2.28	5
12 / .045	880 / 514.5	15.54642	1.71	5

TOTAL METER VOLUME = 35.793
AVG. STACK TEMP (R) = 880
AVG. STACK VEL (FT/SEC) = 15.54267
AVG. STACK VEL (FT/MIN) = 932.5603
AVG. METER TEMP (R) = 511.5
AVG. METER DELTA H (IN.H2O) = 1.719167
AVG. METER PRESSURE (IN.HG) = 29.54641
TOTAL MINS OF TEST = 60
STACK ACFM = 22156.02
STACK DSCFM = 12272.98

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 50.08
AVERAGE STACK TEMPERATURE (R) = 880
TOTAL METER GAS VOL (uncorrected CF) = 35.793
AVG METER TEMP (R) = 511.5
BAROMETRIC PRESSURE (IN.HG) = 29.42
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.719167
AVG. STACK VEL (FT/MIN) = 15.54267
STACK PRESSURE (IN.HG) = 29.4237
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 93.70332 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .2719
SAMPLE WT. (GMS) = .2719
SAMPLE VOL. (DSCFM) = 36.48628
CONCENTRATION (GR/DSCF) = .1149862
% CO2 = 10.17
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1356769
STACK DSCFM = 12272.98
PM EMISSIONS (stk conds) (LB/HR) = 12.09559
PM EMISSIONS (@ 12% CO2) (LB/HR) = 14.27209

***** END OF ANALYSIS FOR RUN # 1 *****

***** RUN # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 279.8167

AMBIENT WET BULB (K) = 277.8722

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 36.48698 DEG. F.

VAPOR PRESSURE (IN.HG) = .2154221

SATURATION VAPOR PRESS. (IN.HG) = .2877726

RELATIVE HUMIDITY (%) = 74.85843

SPECIFIC HUMIDITY (pp1000) = 4.627782

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12

AMBIENT PRESS. (IN.HG) = 29.387

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	53	50	51.5	1.4
2	52	50	51	1.4
3	55	51	53	1.6
4	57	50	53.5	2.01
5	58	52	55	2.01
6	59	53	56	2.01
7	51	51	51	1.4
8	51	50	50.5	1.6
9	52	50	51	2.01
10	51	50	50.5	1.99
11	56	51	53.5	1.6
12	58	51	54.5	1.2

FINAL AVG. METER TEMP (R) = 512.5833

DELTA H0 VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 29.51096

H 2 O T E S T D A T A

START METER READING = 77.441
END METER READING = 112.782
TOTAL CONDENSATE VOL (ML) = 60.34
H2O VAPOR GAS VOLUME @ STP = 2.860116
TOTAL METER GAS VOL (uncorrected CF) = 35.341
AVG. METER TEMP (R) = 512.5833
TOTAL DRY SAMPLE VOL (CF @ STP) = 35.90624
MOLE FRACTION DRY AIR = .9262217
% H2O BY VOL = 7.377831

G A S D E N S I T Y

% CO2 = 10.67
% O2 = 8.07
% CO = 0
% N2 = 78

GAS DENSITY = .9774436

DRY MOL. WT. = 29.1172

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.387
STACK PRESS (IN.HG) = 29.3936
TEST START TIME = 1002

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .035	878 / 511.5	13.78057	1.4	5
2 / .035	878 / 511	13.78057	1.4	5
3 / .04	887 / 513	14.80736	1.6	5
4 / .05	897 / 513.5	16.64819	2.01	5
5 / .05	892 / 515	16.60172	2.01	5
6 / .05	892 / 516	16.60172	2.01	5
7 / .035	880 / 511	13.79625	1.4	5
8 / .04	883 / 510.5	14.77393	1.6	5
9 / .05	885 / 511	16.53645	2.01	5
10 / .05	891 / 510.5	16.59242	1.99	5
11 / .04	891 / 513.5	14.84071	1.6	5
12 / .03	880 / 514.5	12.77285	1.2	5

TOTAL METER VOLUME = 35.341
AVG. STACK TEMP (R) = 886.1667
AVG. STACK VEL (FT/SEC) = 15.12773
AVG. STACK VEL (FT/MIN) = 907.6636
AVG. METER TEMP (R) = 512.5833
AVG. METER DELTA H (IN.H2O) = 1.685834
AVG. METER PRESSURE (IN.HG) = 29.51096
TOTAL MINS OF TEST = 60
STACK ACFM = 21564.52
STACK DSCFM = 11688.72

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 60.34
AVERAGE STACK TEMPERATURE (R) = 886.1667
TOTAL METER GAS VOL (uncorrected CF) = 35.341
AVG METER TEMP (R) = 512.5833
BAROMETRIC PRESSURE (IN.HG) = 29.387
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.685834
AVG. STACK VEL (FT/MIN) = 15.12773
STACK PRESSURE (IN.HG) = 29.3936
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 96.71302 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3003
SAMPLE WT. (GMS) = .3003
SAMPLE VOL. (DSCFM) = 35.90624
CONCENTRATION (GR/DSCF) = .129048
% CO2 = 10.67
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1451337
STACK DSCFM = 11688.72
PM EMISSIONS (stk conds) (LB/HR) = 12.92855
PM EMISSIONS (@ 12% CO2) (LB/HR) = 14.54007

***** END OF ANALYSIS FOR RUN # 2 *****

***** RUN # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 272.5944

AMBIENT WET BULB (K) = 270.3722

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 19.01367 DEG. F.

VAPOR PRESSURE (IN.HG) = .1060571

SATURATION VAPOR PRESS. (IN.HG) = .1733842

RELATIVE HUMIDITY (%) = 61.16885

SPECIFIC HUMIDITY (pp1000) = 2.275113

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12

AMBIENT PRESS. (IN.HG) = 29.2

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	38	36	37	1.54
2	39	37	38	1.93
3	41	37	39	1.93
4	42	37	39.5	1.93
5	42	37	39.5	1.16
6	42	38	40	1.16
7	37	36	36.5	1.16
8	38	37	37.5	1.54
9	39	36	37.5	1.54
10	39	36	37.5	1.93
11	40	36	38	1.74
12	38	35	36.5	1.59

FINAL AVG. METER TEMP (R) = 498.0417

DELTA H@ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 29.31734

H 2 O T E S T D A T A

START METER READING = 113.276
END METER READING = 147.475
TOTAL CONDENSATE VOL (ML) = 56.75
H2O VAPOR GAS VOLUME @ STP = 2.68995
TOTAL METER GAS VOL (uncorrected CF) = 34.19901
AVG. METER TEMP (R) = 498.0417
TOTAL DRY SAMPLE VOL (CF @ STP) = 35.52587
MOLE FRACTION DRY AIR = .9296116
% H2O BY VOL = 7.03884

G A S D E N S I T Y

% CO2 = 10.1
% O2 = 8.53
% CO = 0
% N2 = 78

GAS DENSITY = .9754186

DRY MOL. WT. = 29.0136

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATM(S. PRESS (IN.HG) = 29.2
STACK PRESS (IN.HG) = 29.205
TEST START TIME = 855

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .04	885 / 497	14.85373	1.54	5
2 / .05	911 / 498	16.84915	1.93	5
3 / .05	920 / 499	16.93218	1.93	5
4 / .05	919 / 499.5	16.92297	1.93	5
5 / .03	887 / 499.5	12.87824	1.16	5
6 / .03	879 / 500	12.82003	1.16	5
7 / .03	885 / 496.5	12.86371	1.16	5
8 / .04	890 / 497.5	14.89563	1.54	5
9 / .04	901 / 497.5	14.9874	1.54	5
10 / .05	904 / 497.5	16.78429	1.93	5
11 / .045	901 / 498	15.89654	1.74	5
12 / .04	890 / 496.5	14.89563	1.59	5

TOTAL METER VOLUME = 34.19901
AVG. STACK TEMP (R) = 897.6667
AVG. STACK VEL (FT/SEC) = 15.13163
AVG. STACK VEL (FT/MIN) = 907.8975
AVG. METER TEMP (R) = 498.0417
AVG. METER DELTA H (IN.H2O) = 1.595833
AVG. METER PRESSURE (IN.HG) = 29.31734
TOTAL MINS OF TEST = 60
STACK ACFM = 21570.08
STACK DSCFM = 11510.48

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 56.75
AVERAGE STACK TEMPERATURE (R) = 897.6667
TOTAL METER GAS VOL (uncorrected CF) = 34.19901
AVG METER TEMP (R) = 498.0417
BAROMETRIC PRESSURE (IN.HG) = 29.2
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.595833
AVG. STACK VEL (FT/MIN) = 15.13163
STACK PRESSURE (IN.HG) = 29.205
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT²) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 97.20239 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3812
SAMPLE WT. (GMS) = .3812
SAMPLE VOL. (DSCFM) = 35.52587
CONCENTRATION (GR/DSCF) = .1655671
% CO2 = 10.1
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1967134
STACK DSCFM = 11510.48
PM EMISSIONS (stk conds) (LB/HR) = 16.33424
PM EMISSIONS (@ 12% CO2) (LB/HR) = 19.40702

***** END OF ANALYSIS FOR RUN # 3 ***** 69

PARTICULATE SAMPLING DATA SHEET

SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP			
TRaverse POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP			SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
			(Ts) (°R)				IN (°F)	AVG (Tm) (°R)	OUT (°F)		
<p> $OR = OF + 460$ $H = \left[\frac{5130 \cdot F \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$ </p>											
<p> RUN NUMBER: 813 Bybass (1) DATE: 18 NOV PLANT: GLISSOM SAMPLE BOX NUMBER: Nutech METER BOX NUMBER: RAC Q_m/Q_m: zero leak/run C_o: 5 min/pt </p>											
<p> PROBE LENGTH: 448 NOZZLE AREA (A): 1/16" C_p: 1/16" DRY GAS FRACTION (Fd): Step 77.093 </p>											
1	1437	0.5	5" 420	0.05	1.88	41.300	47	47	47	270	49
2	5	1	4" 420	0.045	1.64		49	48	47		49
3	10	1	5" 420	0.055	2.08		53	50.5	49	248	49
4	15	1	6" 420	0.06	1.90	51.0	56	52.5	49	267	49
5	20	1	6" 420	0.035	1.33		57	53.5	50	271	53
6	25	1	6" 420	0.04	1.52	57.8	57	53.5	50	271	53
<p> CASE 1 1545 5 420 5 420 6 420 9 420 9 420 12 420 </p>											
1	1545	5	5" 420	0.03	1.13		51	51	51	265	48
2	5	5	5" 420	0.035	1.32	62	50	50	50	271	48
3	10	6	6" 420	0.045	1.70		52	51	50	275	54
4	15	9	9" 420	0.055	2.07	68.6	55	52.5	50	269	54
5	20	9	9" 420	0.060	2.28		57	54	51	272	51
6	25	12	12" 420	0.045	1.71		58	54.5	51	275	51
<p> 1615 41.300 35.793 </p>											
<p> 17192 1.72 </p>											

PARTICULATE SAMPLING DATA SHEET

SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP			
TRaverse POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H ₂ O)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP (°F)	OUT (°F)	SAMPLE BOX TEMP (°F)	IMPIINGER CUTLET TEMP (°F)	
<p>RUN NUMBER <u>BLP 8522</u></p> <p>DATE <u>19 Nov 87</u></p> <p>PLANT</p> <p>BASE <u>61550m</u></p> <p>SAMPLE BOX NUMBER <u>Att RHC</u></p> <p>METER BOX NUMBER <u>Metric</u></p> <p>Qw/Qm</p> <p>Co</p>				<p>$H = \left[\frac{5130 \cdot F \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$</p> <p>$OR = OR + 460$</p> <p><u>1.2</u> <u>II</u> <u>I, 255</u></p>				<p>AMBIENT TEMP <u>39</u> °F</p> <p>STATION PRESS <u>24.387</u> in Hg</p> <p>HEATER BOX TEMP °F</p> <p>PROBE HEATER SETTING °F</p> <p>PROBE LENGTH in</p> <p>NOZZLE AREA (A) sq ft <u>0.495</u></p> <p>Cp <u>0.34</u></p> <p>DRY GAS FRACTION (F_d) <u>0.710</u></p>			
1	1000	3	418	0.035	1.00	77.441	53	50	336	45	
2	5	4	418	0.035	1.04		53	50	336	45	
3	10	6	427	0.04	1.60		55	51	361		
4	15	8	437	0.05	2.01		57	53	372		
5	20	14	432	0.05	2.01		57	53	372		
6	25	14	432	0.05	2.01		57	53	372		
1	1000	3	421	0.035	1.4	95.235	51	51	363	43	
2	1213	2	423	0.04	1.6		51	50			
3	5	*	425	0.05	2.01		52	50			
4	10	4	431	0.05	1.94		51	50	365	52	
5	15	5	431	0.05	1.6		51	50	365	53	
6	20	5	431	0.05	1.6		56	51	365		
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6		56	51	365	53	
1	1204	3	420	0.03	1.2	113.001	53	51	365		
2	1213	2	421	0.03	1.6		51	50			
3	5	*	423	0.04	1.6		51	50			
4	10	4	425	0.05	2.01		52	50			
5	15	5	431	0.05	1.94		51	50	365	52	
6	20	5	431	0.05	1.6						

SCHEMATIC OF STACK CROSS SECTION		EQUATIONS		AMBIENT TEMP	
RUN NUMBER	43	R = °F + 460	1,511	STATION PRESS	25
DATE	30 Nov 27	$H = \left[\frac{5130 \cdot F_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$		HEATER BOX TEMP	1420
PLANT	Boiler 3	4.11		PROBE HEATED SETTING	
NAME	Gossin	4.11		PROBE LENGTH	
SAMPLE BOX NUMBER	6	stop	147.475	NOZZLE AREA (A)	147.475
METER BOX NUMBER	1	stop	147.475	DRY GAS FRACTION (F _d)	0.27
EX. NO.	1				
CO.					

TRAVEL POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP		VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP			SAMPLE ROY TEMP (°F)	IMPINGED OUTLET TEMP (°F)
			(°F)	(°R)				IN (°F)	AVG (Tm) (°R)	OUT (°F)		
1	30	3	425		0.01	1.54	22.27	37	37	36	2-33	62
2	30	1	425		0.05	1.13	22.27	38	38	37	2-33	62
3	30	4	425		0.05	1.13		39	39	37	2-33	62
4	30	3	425		0.05	1.13		39.5	39.5	36	2-33	62
5	30	3	425		0.03	1.16		39.5	39.5	36	2-33	62
6	30	3	419		0.03	1.16		40	40	35	2-33	62
7	30	3	425		0.05	1.16	130.519	37	36.5	36	2-33	62
8	30	1	425		0.05	1.16		37	37.5	37	2-33	62
9	30	1	425		0.04	1.54		37	37.5	36	2-33	62
10	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
11	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
12	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
13	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
14	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
15	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
16	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
17	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
18	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
19	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
20	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
21	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
22	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
23	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
24	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
25	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
26	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
27	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
28	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
29	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
30	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
31	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
32	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62
33	30	1	425	0.05	0.04	1.54		37	37.5	36	2-33	62

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>Boiler 3 Griffin</i>	DATE <i>18 Nov</i>	RUN NUMBER <i>#1</i>
BUILDING NUMBER <i>Bypass Run #1</i>	SOURCE NUMBER	

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER <i>#1</i>	<i>0.5137</i>	<i>0.2717</i>	<i>0.2420</i>
ACETONE WASHINGS (Probe, Front Half Filter)	<i>105.1850</i>	<i>105.1551</i>	<i>0.0299</i>
BACK HALF (if needed)			
Total Weight of Particulates Collected			<i>0.2719 gm</i>

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	<i>129</i>	<i>100</i>	<i>29</i>
IMPINGER 2 (H2O)	<i>110</i>	<i>100</i>	<i>10</i>
IMPINGER 3 (Dry)	<i>1</i>	<i>0</i>	<i>1</i>
IMPINGER 4 (Silica Gel) <i>237.7 tare 21.3</i>	<i>216.4</i>	<i>206.32</i>	<i>10.08</i>
<i>216.4</i>	Total Weight of Water Collected		<i>50.08 gm</i>

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>10.05</i>	<i>10.2</i>	<i>10.25</i>		<i>10.17</i>
VOL % O ₂	<i>9.2</i>	<i>9.3</i>	<i>9.6</i>		<i>9.37</i>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE		DATE 8/1/71		RUN NUMBER #2	
BUILDING NUMBER Coker 3 Run #2 Bypass			SOURCE NUMBER		
I. PARTICULATES					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)		
used 2 filters FILTER NUMBER #2	0.8309	0.2755 0.2746	0.2808		
ACETONE WASHINGS (Probe, Front Half Filter)	97.6224	97.6029	0.0195		
BACK HALF (if needed)					
			Total Weight of Particulates Collected		
			.3003 gm		
II. WATER					
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)		
IMPINGER 1 (H2O)	136 101	100	36		
IMPINGER 2 (H2O)	112	100	112		
IMPINGER 3 (Dry)	1	0	1		
IMPINGER 4 (Silica Gel)	259.65 tare 21.3	218.35	207.01	11.34	
100 10 0.5 JOK 218.35	Total Weight of Water Collected			60.34 gm	
III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	10.6	10.6	10.8		
VOL % O ₂	8.0	8.0	8.2		
VOL % CO					
VOL % N ₂					
Vol % N ₂ = (100% - % CO ₂ - % O ₂ - % CO)					

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE Boiler 3 Run 3 DATE 2/25/68 RUN NUMBER # 3
Gypsum

BUILDING NUMBER SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER <u># 3</u>	<u>0.6446</u>	<u>2.2799</u> 0.2799	<u>0.3647</u>
ACETONE WASHINGS (Probe, Front Half Filter)	<u>98.8491</u>	<u>98.8326</u>	<u>0.0165</u>
BACK HALF (if needed)			
Total Weight of Particulates Collected			<u>.3812 gm</u>

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	<u>138</u>	<u>100</u>	<u>38</u>
IMPINGER 2 (H2O)	<u>109</u>	<u>100</u>	<u>9</u>
IMPINGER 3 (Dry)	<u>1</u>	<u>0</u>	<u>1</u>
IMPINGER 4 (Silica Gel) <u>239.35</u> <u>true 21.3</u>	<u>218.05</u>	<u>209.30</u>	<u>8.75</u>
<u>100 wt</u> <u>10</u>	Total Weight of Water Collected		<u>56.75 gm</u>

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<u>10.4</u>	<u>10.2</u>	<u>9.9</u> 10.2	<u>10.2</u>	<u>10.1</u>
VOL % O ₂	<u>8.8</u>	<u>8.7</u>	<u>8.5</u>	<u>8.4</u>	<u>8.53</u>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

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APPENDIX F

Boiler 3, Scrubber Stack

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S O U R C E T E S T R E P O R T

SOURCE :
 GRISSOM AFB CENTRAL HEATING PLANT
 GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #3:SCRUBBER STACK

DATE TESTED : 23 NOV 87

SUBMITTING AGENCY :
 USAFOEHL/ECQ

BROOKS AFB, TX 78235

DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: SCRUBBER Stack diameter at ports: 5.0 (ft)
STACK B

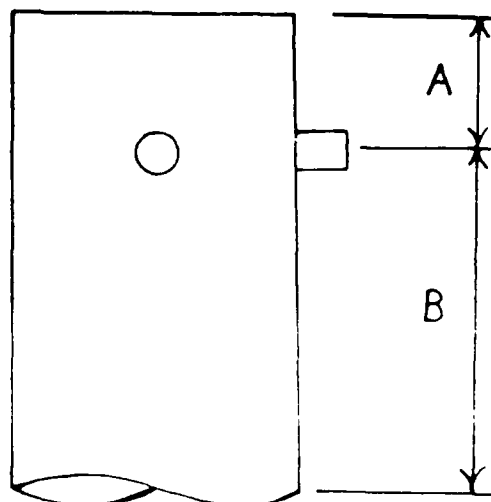
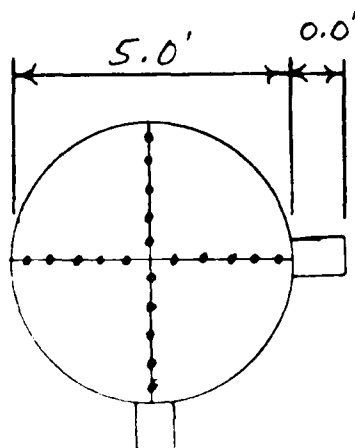
Distance A (ft) 7.0 (duct diameters) 1.4

Recommended number of traverse points as determined by
distance A: 20

Distance B (ft) 28 (duct diameters) 5.6

Recommended number of traverse points as determined by
distance B: 20

Number of traverse points used: 20



TEST TRAVERSE POINT LOCATION

STACK DIAM. (IN.) = 60
STACK RADIUS (IN.) = 30
STACK DIAM. (FT.) = 5
STACK AREA (SQ.FT) = 19.63494

POINT #	DISTANCE IN.
1	1.539501
2	4.9002
3	8.786797
4	13.56832
5	20.51317
6	39.48683
7	46.43168
8	51.21321
9	55.0998
10	58.4605

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5 PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD. TEMP (F) = 68
STD. TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

***** R U N # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 280.9278

AMBIENT WET BULB (K) = 279.2611

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 39.89329 DEG. F.

VAPOR PRESSURE (IN.HG) = .2459105

SATURATION VAPOR PRESS. (IN.HG) = .3103822

RELATIVE HUMIDITY (%) = 79.22828

SPECIFIC HUMIDITY (pp1000) = 5.28485

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20

AMBIENT PRESS. (IN.HG) = 29.02

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	47	47	47	1.84
2	50	48	49	2.14
3	52	48	50	2.53
4	55	49	52	2.78
5	57	49	53	3.21
6	59	50	54.5	3.32
7	61	51	56	3.23
8	61	51	56	3.14
9	63	53	58	3.15
10	63	53	58	2.36
11	63	54	58.5	2.16
12	62	55	58.5	2.36
13	63	55	59	2.46
14	64	55	59.5	2.67
15	65	56	60.5	3.19
16	66	57	61.5	3.28
17	66	57	61.5	3.38
18	67	58	62.5	3.28
19	67	58	62.5	3.47
20	67	58	62.5	2.67

FINAL AVG. METER TEMP (R) = 517

DELTA H0 VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 29.22816

H 2 O T E S T D A T A

START METER READING = 380.784
END METER READING = 428.108
TOTAL CONDENSATE VOL (ML) = 80.8
H2O VAPOR GAS VOLUME @ STP = 3.82992
TOTAL METER GAS VOL (uncorrected CF) = 47.32401
AVG. METER TEMP (R) = 517
TOTAL DRY SAMPLE VOL (CF @ STP) = 47.21335
MOLE FRACTION DRY AIR = .9249672
% H2O BY VOL = 7.503282

G A S D E N S I T Y

% CO2 = 3.37
% O2 = 16.83
% CO = 0
% N2 = 78

GAS DENSITY = .9639005

DRY MOL. WT. = 28.7084

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
 NOZZLE AREA (FT2) = 5.343376E-04
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 29.02
 STACK PRESS (IN.HG) = 29.0288
 TEST START TIME = 830

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .19	570 / 507	26.2145	1.84	3
2 / .22	571 / 509	28.23299	2.14	3
3 / .26	571 / 510	30.69249	2.53	3
4 / .3	571 / 512	32.96902	2.78	3
5 / .33	574 / 513	34.66892	3.21	3
6 / .34	575 / 514.5	35.22093	3.32	3
7 / .33	574 / 516	34.66892	3.23	3
8 / .32	574 / 516	34.13959	3.14	3
9 / .32	573 / 518	34.10984	3.15	3
10 / .24	574 / 518	29.56575	2.36	3
11 / .22	574 / 518.5	28.30706	2.16	3
12 / .24	574 / 518.5	29.56575	2.36	3
13 / .25	574 / 519	30.17542	2.46	3
14 / .27	573 / 519.5	31.33189	2.67	3
15 / .32	570 / 520.5	34.02043	3.19	3
16 / .33	572 / 521.5	34.60847	3.28	3
17 / .34	572 / 521.5	35.12893	3.38	3
18 / .33	573 / 522.5	34.63871	3.28	3
19 / .35	574 / 522.5	35.70404	3.47	3
20 / .27	575 / 522.5	31.38653	2.67	3

TOTAL METER VOLUME = 47.32401
 AVG. STACK TEMP (R) = 572.9
 AVG. STACK VEL (FT/SEC) = 32.26751
 AVG. STACK VEL (FT/MIN) = 1936.051
 AVG. METER TEMP (R) = 517
 AVG. METER DELTA H (IN.H2O) = 2.831
 AVG. METER PRESSURE (IN.HG) = 29.22816
 TOTAL MINS OF TEST = 60
 STACK ACFM = 38014.24
 STACK DSCFM = 31431.38

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 80.8
AVERAGE STACK TEMPERATURE (R) = 572.9
TOTAL METER GAS VOL (uncorrected CF) = 47.32401
AVG METER TEMP (R) = 517
BAROMETRIC PRESSURE (IN.HG) = 29.02
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.831
AVG. STACK VEL (FT/MIN) = 32.26751
STACK PRESSURE (IN.HG) = 29.0288
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT²) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 98.92119 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = 1.1479
SAMPLE WT. (GMS) = 1.1479
SAMPLE VOL. (DSCFM) = 47.21335
CONCENTRATION (GR/DSCF) = .3751502
% CO2 = 3.37
CONCENTRATION @ 12% CO2 (GR/DSCF) = 1.335847
STACK DSCFM = 31431.38
PM EMISSIONS (stk conds) (LB/HR) = 101.0649
PM EMISSIONS (@ 12% CO2) (LB/HR) = 359.8749

***** END OF ANALYSIS FOR RUN # 1 *****

***** RUN # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 285.3722

AMBIENT WET BULB (K) = 281.4833

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 40.28562 DEG. F.

VAPOR PRESSURE (IN.HG) = .2496591

SATURATION VAPOR PRESS. (IN.HG) = .4175718

RELATIVE HUMIDITY (%) = 59.78831

SPECIFIC HUMIDITY (pp1000) = 5.365673

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20

AMBIENT PRESS. (IN.HG) = 29.02

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	59	59	59	2.18
2	61	59	60	2.44
3	64	59	61.5	2.8
4	66	60	63	2.99
5	66	60	63	3.28
6	68	60	64	2.99
7	68	61	64.5	3.08
8	69	61	65	3.03
9	69	61	65	3.06
10	70	62	66	2.47
11	69	63	66	2.26
12	68	63	65.5	2.36
13	69	64	66.5	2.45
14	71	64	67.5	2.62
15	72	65	68.5	2.97
16	73	65	69	3.04
17	74	66	70	3.14
18	75	66	70.5	3.05
19	76	67	71.5	3.09
20	76	68	72	2.85

FINAL AVG. METER TEMP (R) = 525.9

DELTA H@ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 29.22644

H 2 O T E S T D A T A

START METER READING = 428.304
END METER READING = 475.886
TOTAL CONDENSATE VOL (ML) = 81.63
H2O VAPOR GAS VOLUME @ STP = 3.869262
TOTAL METER GAS VOL (uncorrected CF) = 47.582
AVG. METER TEMP (R) = 525.9
TOTAL DRY SAMPLE VOL (CF @ STP) = 46.66461
MOLE FRACTION DRY AIR = .9234323
% H2O BY VOL = 7.656769

G A S D E N S I T Y

% CO2 = 3.03
% O2 = 17.3
% CO = 0
% N2 = 78

GAS DENSITY = .9633582

DRY MOL. WT. = 28.7092

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
 NOZZLE AREA (FT2) = 5.343376E-04
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 29.02
 STACK PRESS (IN.HG) = 29.0288
 TEST START TIME = 1000

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .22	570 / 519	28.21619	2.18	3
2 / .245	570 / 520	29.77626	2.44	3
3 / .28	569 / 521.5	31.80422	2.8	3
4 / .3	572 / 523	33.00717	2.99	3
5 / .33	573 / 523	34.64846	3.28	3
6 / .3	573 / 524	33.03601	2.99	3
7 / .31	575 / 524.5	33.64065	3.08	3
8 / .305	576 / 525	33.39726	3.03	3
9 / .31	579 / 525	33.75746	3.06	3
10 / .25	581 / 526	30.36741	2.47	3
11 / .225	570 / 526	28.53503	2.26	3
12 / .235	570 / 525.5	29.16225	2.36	3
13 / .245	573 / 526.5	29.85451	2.45	3
14 / .26	570 / 527.5	30.67424	2.62	3
15 / .295	572 / 528.5	32.73095	2.97	3
16 / .3	569 / 529	32.9205	3.04	3
17 / .31	570 / 530	33.49407	3.14	3
18 / .3	569 / 530.5	32.9205	3.05	3
19 / .305	571 / 531.5	33.25198	3.09	3
20 / .28	570 / 532	31.83216	2.85	3

TOTAL METER VOLUME = 47.582
 AVG. STACK TEMP (R) = 572.1
 AVG. STACK VEL (FT/SEC) = 31.85136
 AVG. STACK VEL (FT/MIN) = 1911.082
 AVG. METER TEMP (R) = 525.9
 AVG. METER DELTA H (IN.H2O) = 2.8075
 AVG. METER PRESSURE (IN.HG) = 29.22644
 TOTAL MINS OF TEST = 60
 STACK ACFM = 37523.97
 STACK DSCFM = 31017.85

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 81.63
AVERAGE STACK TEMPERATURE (R) = 572.1
TOTAL METER GAS VOL (uncorrected CF) = 47.582
AVG METER TEMP (R) = 525.9
BAROMETRIC PRESSURE (IN.HG) = 29.02
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.8075
AVG. STACK VEL (FT/MIN) = 31.85136
STACK PRESSURE (IN.HG) = 29.0288
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.06254 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = .4026
FINAL FILTER WT. (GMS) = .8052
SAMPLE WT. (GMS) = .4026
SAMPLE VOL. (DSCFM) = 46.66461
CONCENTRATION (GR/DSCF) = .1331227
% CO2 = 3.03
CONCENTRATION @ 12% CO2 (GR/DSCF) = .5272185
STACK DSCFM = 31017.85
PM EMISSIONS (stk conds) (LB/HR) = 35.39119
PM EMISSIONS (@ 12% CO2) (LB/HR) = 140.1631

***** END OF ANALYSIS FOR RUN # 2 *****

***** RUN # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 285.9278

AMBIENT WET BULB (K) = 282.5945

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 43.74922 DEG. F.

VAPOR PRESSURE (IN.HG) = .2850438

SATURATION VAPOR PRESS. (IN.HG) = .4330654

RELATIVE HUMIDITY (%) = 65.82003

SPECIFIC HUMIDITY (pp1000) = 6.128993

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20

AMBIENT PRESS. (IN.HG) = 29.02

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	68	69	68.5	2.22
2	72	69	70.5	2.41
3	72	69	70.5	2.8
4	73	69	71	3.1
5	74	70	72	3.37
6	75	69	72	3.15
7	77	70	73.5	3.05
8	77	71	74	3.09
9	78	71	74.5	3.08
10	78	71	74.5	2.53
11	76	71	73.5	2.53
12	75	71	73	2.53
13	76	71	73.5	2.54
14	76	70	73	2.79
15	76	70	73	2.99
16	75	70	72.5	3.24
17	76	70	73	3.57
18	76	70	73	3.39
19	76	70	73	3.42
20	76	70	73	3.35

FINAL AVG. METER TEMP (R) = 532.575

DELTA H@ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 29.23746

H 2 O T E S T D A T A

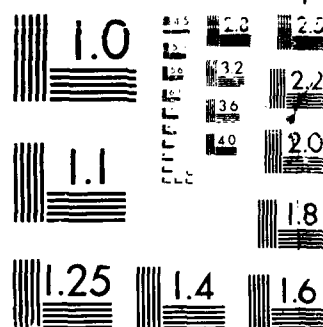
START METER READING = 476.041
END METER READING = 524.95
TOTAL CONDENSATE VOL (ML) = 82.26
H2O VAPOR GAS VOLUME @ STP = 3.899124
TOTAL METER GAS VOL (uncorrected CF) = 48.90903
AVG. METER TEMP (R) = 532.575
TOTAL DRY SAMPLE VOL (CF @ STP) = 47.38275
MOLE FRACTION DRY AIR = .9239668
% H2O BY VOL = 7.603319

G A S D E N S I T Y

% CO2 = 3.1
% O2 = 17
% CO = 0
% N2 = 78

GAS DENSITY = .961475

DRY MOL. WT. = 28.644



MICROCOPY RESOLUTION TEST CHART
 NATIONAL BUREAU OF STANDARDS-1963-A

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
 NOZZLE AREA (FT2) = 5.343376E-04
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 29.02
 STACK PRESS (IN.HG) = 29.0288
 TEST START TIME = 1136

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .22	570 / 528.5	28.24381	2.22	3
2 / .24	575 / 530.5	29.6288	2.41	3
3 / .28	578 / 530.5	32.08614	2.8	3
4 / .31	578 / 531	33.76131	3.1	3
5 / .335	576 / 532	35.03549	3.37	3
6 / .315	580 / 532	34.09132	3.15	3
7 / .305	581 / 533.5	33.57473	3.05	3
8 / .31	584 / 534	33.93609	3.09	3
9 / .31	587 / 534.5	34.02315	3.08	3
10 / .255	588 / 534.5	30.88398	2.53	3
11 / .25	575 / 533.5	30.23977	2.53	3
12 / .25	575 / 533	30.23977	2.53	3
13 / .255	583 / 533.5	30.75239	2.54	3
14 / .28	584 / 533	32.25225	2.79	3
15 / .3	583 / 533	33.35565	2.99	3
16 / .325	583 / 532.5	34.71766	3.24	3
17 / .355	577 / 533	36.09746	3.57	3
18 / .34	583 / 533	35.50981	3.39	3
19 / .345	586 / 533	35.86187	3.42	3
20 / .34	589 / 533	35.69206	3.35	3

TOTAL METER VOLUME = 48.90903
 AVG. STACK TEMP (R) = 580.75
 AVG. STACK VEL (FT/SEC) = 32.99918
 AVG. STACK VEL (FT/MIN) = 1979.951
 AVG. METER TEMP (R) = 532.575
 AVG. METER DELTA H (IN.H2O) = 2.9575
 AVG. METER PRESSURE (IN.HG) = 29.23746
 TOTAL MINS OF TEST = 60
 STACK ACFM = 38876.22
 STACK DSCFM = 31675.31

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 82.26
AVERAGE STACK TEMPERATURE (R) = 580.75
TOTAL METER GAS VOL (uncorrected CF) = 48.90903
AVG METER TEMP (R) = 532.575
BAROMETRIC PRESSURE (IN.HG) = 29.02
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.9575
AVG. STACK VEL (FT/MIN) = 32.99918
STACK PRESSURE (IN.HG) = 29.0288
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT²) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 98.50356 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3033
SAMPLE WT. (GMS) = .3033
SAMPLE VOL. (DSCFM) = 47.38275
CONCENTRATION (GR/DSCF) = 9.876841E-02
% CO2 = 3.1
CONCENTRATION @ 12% CO2 (GR/DSCF) = .3823294
STACK DSCFM = 31675.31
PM EMISSIONS (stk conds) (LB/HR) = 26.81455
PM EMISSIONS (@ 12% CO2) (LB/HR) = 103.7982

***** END OF ANALYSIS FOR RUN # 3 *****

PARTICULATE SAMPLING DATA SHEET

SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP				
TRaverse POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (in)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP (°F)	IN (°F)	OUT (°F)	Avg (T _m) (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	0830	12.3	110	.19	1.84	380.784	47	47	47	47	230	52
2	3	3	110	.22	2.14		50	50	48	48	230.1	57
3	6	4	111	.26	2.53		52	52	48	50	242	53
4	9	5	111	.30	2.78		55	55	49	52	250	54
5	12	5	114	.33	3.21		57	57	49	53	248	55
6	15	6	114	.34	3.32		59	59	50	54.5	252	59
7	18	6	114	.33	3.23		61	61	51	56	252	56
8	21	6	114	.32	3.14		61	61	51	56	252	54
9	24	6	113	.32	3.15		63	63	53	58	251	53
10	27	5	114	.24	2.96	404.146	63	63	53	58	248	57
1	0905	5	114	.22	2.16		63	63	54	58.5	247	57
2	3	5	114	.24	2.36		62	62	55	58.5	247	58
3	6	5	114	.25	2.46		63	63	55	58.5	246	57
4	9	5	113	.27	2.67		64	64	55	58.5	243	56
5	12	6	110	.33	3.28		65	65	56	60.5	254	57
6	15	6	112	.33	3.28		66	66	57	61.5	244	53
7	18	7	112	.34	3.38		66	66	57	61.5	247	58
8	21	7	113	.33	3.28		67	67	58	62.5	257	60
9	24	7	114	.33	3.47		67	67	58	62.5	257	60
10	27	7	115	.27	2.67		67	67	58	62.5	246	63
	30					428.108						
					2.83	47.324				57		

OEM FORM MAY 78 18

PARTICULATE SAMPLING DATA SHEET

SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP				
RUN NUMBER	DATE	PLANT	BASE	$^{\circ}R = ^{\circ}F + 460$	$H = \left[\frac{5130 \cdot F \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$	STATION PRESS	HEATER BOX TEMP	PROBE HEATER SETTING	PROBE LENGTH	NOZZLE AREA (A)	C_p	C_d
TRAVEL POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (in)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP (°F)	IMPINGER OUTLET TEMP (°F)				
1	1000	12	110	0.22	2.18	428.304	59	51	6'	6.1755	1	2690 (14014)
2	3	1	110	0.245	2.44		61	59				
3	6	6	109	0.28	2.99		64	59				
4	9	6	112	0.3	3.28		66	60				
5	12	7	113	0.33	3.28		68	60				
6	15	6.5	113	0.30	2.99		68	60				
7	18	7	115	0.31	3.08		69	61				
8	21	7	116	0.305	3.03		69	61				
9	24	7	119	0.31	3.06		70	61				
10	27	6	121	0.25	2.47		70	61				
1	1034	5	110	0.235	2.26	452.183	69	63				
2	3	5.5	110	0.235	2.36		69	63				
3	6	6	113	0.245	2.45		69	63				
4	9	6.5	110	0.26	2.62		71	64				
5	12	7	112	0.295	2.97		72	65				
6	15	7.5	109	0.30	3.04		73	65				
7	18	8	110	0.31	3.14		74	66				
8	21	8	109	0.30	3.05		75	66				
9	24	8	111	0.305	3.09		76	67				
10	27	8	110	0.28	2.85		76	68				
	30				2.8075	475.886						
					2.8075	475.886						



START 428.304

3min RT

OEHL FORM 18
MAY 78

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>03 R1 Sample</i>	DATE	RUN NUMBER <i># 11</i>
BUILDING NUMBER	SOURCE NUMBER	

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	<i>0.2997</i>	<i>0.2756</i>	<i>0.0241</i>
ACETONE WASHINGS (Probe, Front Half Filter)	<i>103.5539</i>	<i>102.4301</i>	<i>9.1.1238</i>
BACK HALF (if needed)			
	Total Weight of Particulates Collected		<i>1.1479 gm</i>

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H ₂ O)	<i>147</i>	<i>100</i>	<i>47</i>
IMPINGER 2 (H ₂ O)	<i>15</i>	<i>100</i>	<i>18</i>
IMPINGER 3 (Dry)	<i>2.8</i>	<i>0</i>	<i>2.8</i>
IMPINGER 4 (Silica Gel)	<i>214.05</i>	<i>201.05</i>	<i>13.0</i>
	Total Weight of Water Collected		<i>60.8 gm</i>

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>3.2</i>	<i>3.7</i>	<i>1</i>		<i>3.37</i>
VOL % O ₂	<i>16.5</i>	<i>6.5</i>	<i>16</i>		<i>16.83</i>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>FS #2 Scrubber</i>	DATE	RUN NUMBER <i>#12</i>
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BUILDING NUMBER	SOURCE NUMBER
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I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	<i>0.3033</i>	<i>0.2775</i>	<i>0.0258</i>
ACETONE WASHINGS (Probe, Front Half Filter)	<i>105.7493</i>	<i>105.3725</i>	<i>0.3768</i>
BACK HALF (If needed)			
	Total Weight of Particulates Collected		<i>.4026 gm</i>

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H ₂ O)	<i>133</i>	<i>100</i>	<i>33</i>
IMPINGER 2 (H ₂ O)	<i>125</i>	<i>100</i>	<i>25</i>
IMPINGER 3 (Dry)	<i>5.4</i>	<i>0</i>	<i>5.4</i>
IMPINGER 4 (Silica Gel)	<i>220.00</i>	<i>201.77</i>	<i>18.23</i>
	Total Weight of Water Collected		<i>81.63 gm</i>

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>2.9</i>	<i>3</i>	<i>3.2</i>		<i>3.03</i>
VOL % O ₂	<i>17.3</i>	<i>17.2</i>	<i>17.4</i>		<i>17.3</i>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>B3R3 Scrubber</i>	DATE	RUN NUMBER <i>#13</i>
BUILDING NUMBER		SOURCE NUMBER

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	<i>0.3086</i>	<i>0.2778</i>	<i>0.0308</i>
ACETONE WASHINGS (Probe, Front Half Filter)	<i>100.6792</i>	<i>100.4067</i>	<i>0.2725</i>
BACK HALF (if needed)			
Total Weight of Particulates Collected			<i>.3033 gm</i>

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	<i>153</i>	<i>100</i>	<i>53</i>
IMPINGER 2 (H2O)	<i>112</i>	<i>100</i>	<i>12</i>
IMPINGER 3 (Dry)	<i>2.2</i>	<i>0</i>	<i>2.2</i>
IMPINGER 4 (Silica Gel) <i>237.8</i> <i>21.3</i>	<i>216.5</i>	<i>201.44</i>	<i>15.06</i>
Total Weight of Water Collected			<i>82.26 gm</i>

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>3.1</i>	<i>3.2</i>	<i>3.0</i>		<i>3.1</i>
VOL % O ₂	<i>16.8</i>	<i>17.0</i>	<i>17.1</i>		<i>16.9</i>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

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APPENDIX G

Boiler 4, Bypass Stack

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S O U R C E T E S T R E P O R T

SOURCE :
 GRISSOM AFB CENTRAL HEATING PLANT
 GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #4:BYPASS STACK

DATE TESTED : 21 NOV 87

SUBMITTING AGENCY :
 USAFOEHL/ECQ

 BROOKS AFB, TX 78235

DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: BYPASS Stack diameter at ports: 5.5 (ft)

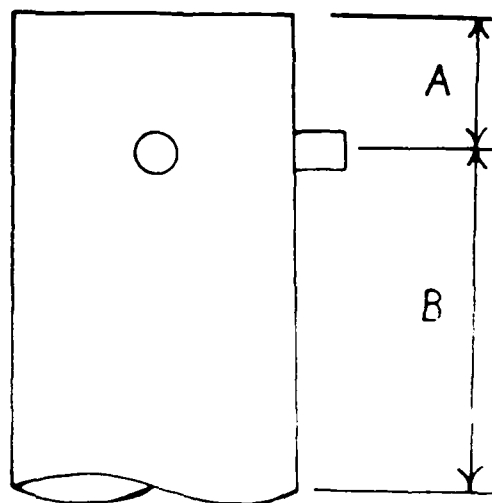
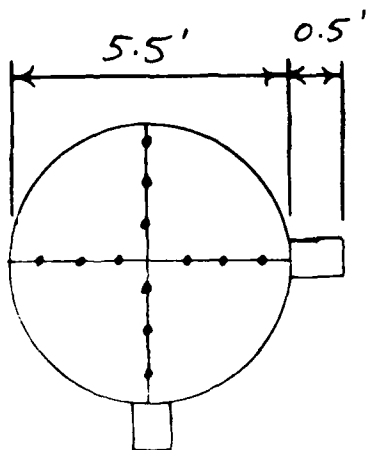
Distance A (ft) 11.5 (duct diameters) 2.1

Recommended number of traverse points as determined by
distance A: 12

Distance B (ft) 39.5 (duct diameters) 7.2

Recommended number of traverse points as determined by
distance B: 12

Number of traverse points used: 12



TEST TRAVERSE POINT LOCATION

STACK DIAM. (IN.) = 66
STACK RADIUS (IN.) = 33
STACK DIAM. (FT.) = 5.5
STACK AREA (SQ.FT) = 23.75828

POINT #	DISTANCE IN.
1	2.875261
2	9.665478
3	19.52781
4	46.4722
5	56.33452
6	63.12474

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5 PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD. TEMP (F) = 68
STD. TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

***** RUN # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 269.2611

AMBIENT WET BULB (K) = 268.15

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 18.65837 DEG. F.

VAPOR PRESSURE (IN.HG) = .1044835

SATURATION VAPOR PRESS. (IN.HG) = .1359793

RELATIVE HUMIDITY (%) = 76.83784

SPECIFIC HUMIDITY (pp1000) = 2.24131

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12

AMBIENT PRESS. (IN.HG) = 30.33

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	44	42	43	.79
2	48	43	45.5	1.58
3	52	45	48.5	1.59
4	55	46	50.5	1.59
5	57	47	52	1.195
6	57	49	53	1.4
7	50	48	49	.79
8	51	49	50	1.59
9	53	49	51	1.99
10	54	50	52	1.79
11	53	49	51	1.59
12	53	49	51	1.6

FINAL AVG. METER TEMP (R) = 509.7084

DELTA H0 VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 30.4372

H 2 O T E S T D A T A

START METER READING = 147.777
END METER READING = 180.796
TOTAL CONDENSATE VOL (ML) = 58.42
H2O VAPOR GAS VOLUME @ STP = 2.769108
TOTAL METER GAS VOL (uncorrected CF) = 33.01901
AVG. METER TEMP (R) = 509.7084
TOTAL DRY SAMPLE VOL (CF @ STP) = 34.79521
MOLE FRACTION DRY AIR = .9262836
% H2O BY VOL = 7.371646

G A S D E N S I T Y

% CO2 = 9.13
% O2 = 9.2
% CO = 0
% N2 = 78

GAS DENSITY = .9673566

DRY MOL. WT. = 28.8012

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
 NOZZLE AREA (FT2) = 1.352651E-03
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 30.33
 STACK PRESS (IN.HG) = 30.3381
 TEST START TIME = 924

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .02	880 / 503	10.31874	.79	5
2 / .04	880 / 505.5	14.59291	1.58	5
3 / .04	881 / 508.5	14.6012	1.59	5
4 / .04	883 / 510.5	14.61776	1.59	5
5 / .03	871 / 512	12.57304	1.195	5
6 / .035	875 / 513	13.61158	1.4	5
7 / .02	880 / 509	10.31874	.79	5
8 / .04	880 / 510	14.59291	1.59	5
9 / .05	882 / 511	16.3339	1.99	5
10 / .045	884 / 512	15.51326	1.79	5
11 / .04	881 / 511	14.6012	1.59	5
12 / .04	875 / 511	14.55139	1.6	5

TOTAL METER VOLUME = 33.01901
 AVG. STACK TEMP (R) = 879.3333
 AVG. STACK VEL (FT/SEC) = 13.85222
 AVG. STACK VEL (FT/MIN) = 831.1331
 AVG. METER TEMP (R) = 509.7084
 AVG. METER DELTA H (IN.H2O) = 1.457917
 AVG. METER PRESSURE (IN.HG) = 30.4372
 TOTAL MINS OF TEST = 60
 STACK ACFM = 19746.29
 STACK DSCFM = 11133.22

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 58.42
AVERAGE STACK TEMPERATURE (R) = 879.3333
TOTAL METER GAS VOL (uncorrected CF) = 33.01901
AVG METER TEMP (R) = 509.7084
BAROMETRIC PRESSURE (IN.HG) = 30.33
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.457917
AVG. STACK VEL (FT/MIN) = 13.85222
STACK PRESSURE (IN.HG) = 30.3381
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 98.39307 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .4139
SAMPLE WT. (GMS) = .4139
SAMPLE VOL. (DSCFM) = 34.79521
CONCENTRATION (GR/DSCF) = .1835448
% CO2 = 9.13
CONCENTRATION @ 12% CO2 (GR/DSCF) = .2412418
STACK DSCFM = 11133.22
PM EMISSIONS (stk conds) (LB/HR) = 17.51436
PM EMISSIONS (@ 12% CO2) (LB/HR) = 23.01996

***** END OF ANALYSIS FOR RUN # 1 *****

***** RUN # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 273.7055

AMBIENT WET BULB (K) = 270.9278

SCURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 18.03984 DEG. F.

VAPOR PRESSURE (IN.HG) = .1017945

SATURATION VAPOR PRESS. (IN.HG) = .1877665

RELATIVE HUMIDITY (%) = 54.21335

SPECIFIC HUMIDITY (pp1000) = 2.18355

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12

AMBIENT PRESS. (IN.HG) = 30.33

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	51	50	50.5	1.2
2	53	50	51.5	1.6
3	55	50	52.5	2.2
4	57	51	54	2.41
5	59	52	55.5	1.81
6	60	52	56	1.41
7	55	53	54	1.2
8	60	55	57.5	1.62
9	64	57	60.5	1.62
10	66	58	62	1.63
11	66	59	62.5	1.65
12	67	60	63.5	1.46

FINAL AVG. METER TEMP (R) = 516.6667

DE_LTA H@ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 30.45138

H 2 O T E S T D A T A

START METER READING = 181.07
END METER READING = 216.608
TOTAL CONDENSATE VOL (ML) = 65.54
H2O VAPOR GAS VOLUME @ STP = 3.106596
TOTAL METER GAS VOL (uncorrected CF) = 35.538
AVG. METER TEMP (R) = 516.6667
TOTAL DRY SAMPLE VOL (CF @ STP) = 36.96254
MOLE FRACTION DRY AIR = .9224691
% H2O BY VOL = 7.753089

G A S D E N S I T Y

% CO2 = 9.33
% O2 = 10.1
% CO = 0
% N2 = 78

GAS DENSITY = .9779143

DRY MOL. WT. = 29.1772

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
 NOZZLE AREA (FT2) = 1.352651E-03
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 30.33
 STACK PRESS (IN.HG) = 30.3381
 TEST START TIME = 1201

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .03	880 / 510.5	12.56943	1.2	5
2 / .04	880 / 511.5	14.51392	1.6	5
3 / .055	868 / 512.5	16.90264	2.2	5
4 / .06	865 / 514	17.6237	2.41	5
5 / .045	879 / 515.5	15.38559	1.81	5
6 / .035	881 / 516	13.58424	1.41	5
7 / .03	880 / 514	12.56943	1.2	5
8 / .04	880 / 517.5	14.51392	1.62	5
9 / .04	862 / 520.5	14.36472	1.62	5
10 / .04	870 / 522	14.43122	1.63	5
11 / .04	868 / 522.5	14.41462	1.65	5
12 / .035	863 / 523.5	13.44476	1.46	5

TOTAL METER VOLUME = 35.538
 AVG. STACK TEMP (R) = 873
 AVG. STACK VEL (FT/SEC) = 14.52652
 AVG. STACK VEL (FT/MIN) = 871.5909
 AVG. METER TEMP (R) = 516.6667
 AVG. METER DELTA H (IN.H2O) = 1.650833
 AVG. METER PRESSURE (IN.HG) = 30.45138
 TOTAL MINS OF TEST = 60
 STACK ACFM = 20707.5
 STACK DSCFM = 11711.43

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 65.54
AVERAGE STACK TEMPERATURE (R) = 873
TOTAL METER GAS VOL (uncorrected CF) = 35.538
AVG METER TEMP (R) = 516.6667
BAROMETRIC PRESSURE (IN.HG) = 30.33
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.650833
AVG. STACK VEL (FT/MIN) = 14.52652
STACK PRESSURE (IN.HG) = 30.3381
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.33039 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .5538
SAMPLE WT. (GMS) = .5538
SAMPLE VOL. (DSCFM) = 36.96254
CONCENTRATION (GR/DSCF) = .2311836
% CO2 = 9.33
CONCENTRATION @ 12% CO2 (GR/DSCF) = .2973423
STACK DSCFM = 11711.43
PM EMISSIONS (stk conds) (LB/HR) = 23.2059
PM EMISSIONS (@ 12% CO2) (LB/HR) = 29.84682

***** END OF ANALYSIS FOR RUN # 2 *****

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***** RUN # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 274.2611

AMBIENT WET BULB (K) = 271.4833

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 19.4752 DEG. F.

VAPOR PRESSURE (IN.HG) = .1081325

SATURATION VAPOR PRESS. (IN.HG) = .1953517

RELATIVE HUMIDITY (%) = 55.35275

SPECIFIC HUMIDITY (pp1000) = 2.319696

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12

AMBIENT PRESS. (IN.HG) = 30.33

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	62	62	62	1.02
2	63	62	62.5	1.63
3	67	63	65	1.84
4	69	64	66.5	1.64
5	70	64	67	1.64
6	71	65	68	1.44
7	68	66	67	.82
8	68	66	67	1.44
9	67	66	66.5	2.05
10	68	66	67	1.85
11	68	65	66.5	1.64
12	68	65	66.5	1.23

FINAL AVG. METER TEMP (R) = 525.9583

DELTA H₀ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 30.44177

H 2 O T E S T D A T A

START METER READING = 216.808
END METER READING = 251.399
TOTAL CONDENSATE VOL (ML) = 60.36
H2O VAPOR GAS VOLUME @ STP = 2.861064
TOTAL METER GAS VOL (uncorrected CF) = 34.591
AVG. METER TEMP (R) = 525.9583
TOTAL DRY SAMPLE VOL (CF @ STP) = 35.33084
MOLE FRACTION DRY AIR = .9250871
% H2O BY VOL = 7.491285

G A S D E N S I T Y

% CO2 = 9.53
% O2 = 9.43
% CO = 0
% N2 = 78

GAS DENSITY = .9748861

DRY MOL. WT. = 29.0508

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT²) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.33
STACK PRESS (IN.HG) = 30.3381
TEST START TIME = 1415

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .025	880 / 522	11.49207	1.02	5
2 / .04	880 / 522.5	14.53645	1.63	5
3 / .045	887 / 525	15.47943	1.84	5
4 / .04	887 / 526.5	14.59415	1.64	5
5 / .04	886 / 527	14.58592	1.64	5
6 / .035	877 / 528	13.5744	1.44	5
7 / .02	880 / 527	10.27882	.82	5
8 / .035	880 / 527	13.5976	1.44	5
9 / .05	882 / 526.5	16.2707	2.05	5
10 / .045	888 / 527	15.48816	1.85	5
11 / .04	878 / 526.5	14.51992	1.64	5
12 / .03	866 / 526.5	12.48839	1.23	5

TOTAL METER VOLUME = 34.591
AVG. STACK TEMP (R) = 880.9167
AVG. STACK VEL (FT/SEC) = 13.90883
AVG. STACK VEL (FT/MIN) = 834.53
AVG. METER TEMP (R) = 525.9583
AVG. METER DELTA H (IN.H2O) = 1.52
AVG. METER PRESSURE (IN.HG) = 30.44177
TOTAL MINS OF TEST = 60
STACK ACFM = 19826.99
STACK DSCFM = 11144.21

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 60.36
AVERAGE STACK TEMPERATURE (R) = 880.9167
TOTAL METER GAS VOL (uncorrected CF) = 34.591
AVG METER TEMP (R) = 525.9583
BAROMETRIC PRESSURE (IN.HG) = 30.33
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.52
AVG. STACK VEL (FT/MIN) = 13.90883
STACK PRESSURE (IN.HG) = 30.3381
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.7994 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3345
SAMPLE WT. (GMS) = .3345
SAMPLE VOL. (DSCFM) = 35.33084
CONCENTRATION (GR/DSCF) = .1460859
% CO2 = 9.53
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1839486
STACK DSCFM = 11144.21
PM EMISSIONS (stk conds) (LB/HR) = 13.95369
PM EMISSIONS (@ 12% CO2) (LB/HR) = 17.57023

***** END OF ANALYSIS FOR RUN # 3 *****

PARTICULATE SAMPLING DATA SHEET

PLANT NUMBER Bypass Run #1 Lower 4 51,110 (Sat)		SCHEMATIC OF STACK CROSS SECTION		EQUATIONS $OR = OF + 460$ $H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co} \right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$ 1100 (+) 5.1 1100 (-) 3.3 0.74 3.3 V		AMBIENT TEMP 36 STATION PRESS 30.33 HEATER BOX TEMP PROBE HEATER SETTING PROBE LENGTH 3' 11.000 NOZZLE AREA (A) 0.498 Cp 1.84 DRY GAS FRACTION (F_d) .7	
PLANT J-S-3000- SAMPLE BOX NUMBER R11C METER BOX NUMBER 11111111		Leak Check good 2/24/11 @ 22 m Hg 5 mm Hg		Start 147.707			

TRAVEL POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP		VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP		SAMPLE BOX TEMP (OF)	IMPIINGER OUTLET TEMP (OF)
			(OF)	(TS) (OR)				IN (OF)	AVG (TM) (OR)		
1	0.24	0.11	420		0.02	0.79	142.227	44	43	270	46
2	5	1	420		0.04	1.58		48	45	265	45
3	10	5	421		0.04	1.54		52	45	259	45
4	15	5	423		0.04	1.54		52	46	268	45
5	20	14	411		0.04	0.82	1.195	57	47	267	45
6	25	14	415		0.035	1.40	163.783	57	53	268	45
7	30										
8	100.4		420		0.02	0.79		50	49	259	59
9	5	15	420		0.04	1.59		51	50	259	60
10	10	20	422		0.04	1.99		53	51	261	58
11	15	20	424		0.045	1.79		54	52	258	53
12	20	19.5	421		0.04	1.59		53	51	257	51
13	25	20	415		0.04	1.60		53	51	253	52
14	30										
15					5.63						
16					419.3		180.769				
17					10	1.46	32.9920				
18					14	1.43			49.71		
19					14						
20					420						
21					412						
22					420						
23					13						
24					14						

PARTICULATE SAMPLING DATA SHEET

SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP							
TRAVELSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (V _p)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	IN (°F)	AVG (T _m) (°F)	OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)				
<p>Run #2 Boiler</p> <p>21 Nov (Sat)</p> <p>Plant</p> <p>Base</p> <p>Sample Box Number</p> <p>Meter Box Number</p> <p>Q_w/Q_m</p> <p>Co</p>				<p>Soot blower (intermittent)</p> <p>Backdraft = 1200 Wk</p> <p>(@ 12" Hg)</p> <p>5 min / pt</p>				<p> $Q_R = 0.7 + 460$ $H = \left[\frac{5130 \cdot F_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_p$ <p>+ put 2.8</p> <p>- put 2.1</p> </p>				<p>46</p> <p>Station Press</p> <p>30.33</p> <p>Heater Box Temp</p> <p>Probe Heater Setting</p> <p>Probe Length</p> <p>5' 10" 10"</p> <p>Nozzle Area (A)</p> <p>.4438</p> <p>C_p</p> <p>.84</p> <p>Dry Gas Fraction (F_d)</p> <p>.7</p>			
1	1201	0.11	420	0.03	1.2	18.070	5.1	50.5	50	53.8	58				
2	1202	0.11	420	0.04	1.6		5.3	50.5	50	53.8	63				
3	1203	0.11	408	0.05	2.3		5.5	50.5	50	53.8	63				
4	1204	0.11	405	0.06	2.7		5.7	54	51	53.8	54				
5	1205	0.11	419	0.045	1.8		5.7	50.5	50	53.8	54				
6	1206	0.11	421	0.035	1.4		6.0	50.5	50	53.8	54				
7	1207	0.11	420	0.03	1.2	149.336	5.5	50.5	50	53.8	47				
8	1208	0.11	420	0.04	1.6		6.0	50.5	50	53.8	50				
9	1209	0.11	402	0.04	1.6		5.1	50.5	50	53.8	50				
10	1210	0.11	410	0.04	1.6		5.6	50.5	50	53.8	51				
11	1211	0.11	402	0.04	1.6		6.0	50.5	50	53.8	51				
12	1212	0.11	403	0.035	1.4		6.7	50.5	50	53.8	51				
13	1213	0.11	403	0.035	1.4	26.608		50.5	50	53.8	51				
14	1214	0.11	403	0.035	1.4			50.5	50	53.8	51				
15	1215	0.11	403	0.035	1.4			50.5	50	53.8	51				
16	1216	0.11	403	0.035	1.4			50.5	50	53.8	51				
17	1217	0.11	403	0.035	1.4			50.5	50	53.8	51				
18	1218	0.11	403	0.035	1.4			50.5	50	53.8	51				
19	1219	0.11	403	0.035	1.4			50.5	50	53.8	51				
20	1220	0.11	403	0.035	1.4			50.5	50	53.8	51				
21	1221	0.11	403	0.035	1.4			50.5	50	53.8	51				
22	1222	0.11	403	0.035	1.4			50.5	50	53.8	51				
23	1223	0.11	403	0.035	1.4			50.5	50	53.8	51				
24	1224	0.11	403	0.035	1.4			50.5	50	53.8	51				
25	1225	0.11	403	0.035	1.4			50.5	50	53.8	51				
26	1226	0.11	403	0.035	1.4			50.5	50	53.8	51				
27	1227	0.11	403	0.035	1.4			50.5	50	53.8	51				
28	1228	0.11	403	0.035	1.4			50.5	50	53.8	51				
29	1229	0.11	403	0.035	1.4			50.5	50	53.8	51				
30	1230	0.11	403	0.035	1.4			50.5	50	53.8	51				

PARTICULATE SAMPLING DATA SHEET

EQUATIONS

$$OR = OF + 460$$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co} \right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

SCHEMATIC OF STACK CROSS SECTION

RUN NUMBER #3 000004	BASE 100000
SAMPLE BOX NUMBER 100000	METER BOX NUMBER 100000
PLANT 100000	DATE 100000
TIME 100000	LOCATION 100000
COMMENTS 100000	SIGNATURE 100000

TRAVEL POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O) (in)	STACK TEMP		VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP			SAMPLE BOX TEMP (OF)	IMPINGER OUTLET TEMP (OF)
			(OF)	(Tm) (OF)				IN (OF)	AVG (Tm) (OF)	OUT (OF)		
1	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
2	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
3	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
4	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
5	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
6	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
7	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
8	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
9	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
10	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
11	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
12	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
13	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
14	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
15	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
16	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
17	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
18	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
19	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
20	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
21	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
22	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
23	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
24	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
25	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
26	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
27	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
28	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
29	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
30	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
31	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
32	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
33	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
34	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
35	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
36	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
37	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
38	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
39	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
40	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
41	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
42	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
43	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
44	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
45	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
46	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
47	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
48	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
49	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
50	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
51	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
52	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
53	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
54	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
55	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
56	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
57	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
58	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
59	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
60	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
61	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
62	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
63	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
64	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
65	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
66	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
67	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
68	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
69	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
70	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
71	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
72	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
73	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
74	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
75	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
76	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
77	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
78	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
79	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
80	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
81	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
82	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
83	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
84	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
85	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
86	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
87	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
88	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
89	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
90	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
91	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
92	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
93	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
94	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
95	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
96	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
97	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
98	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
99	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52
100	1520	5	420	420	0.035	1.03	216.803	63	63	62	251	52

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>Bypass</i> <i>Run 1</i>	DATE	RUN NUMBER <i>Run #4</i>
BUILDING NUMBER		SOURCE NUMBER

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.6394	0.2748 0.2755	0.3646
ACETONE WASHINGS (Probe, Front Half Filter)	99.1560	99.1067	0.0493
BACK HALF (if needed)			
Total Weight of Particulates Collected			.4139 gm

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	126	100	26
IMPINGER 2 (H2O)	118	100	18
IMPINGER 3 (Dry)	3	0	3
IMPINGER 4 (Silica Gel)	215.4	203.98	11.42
Total Weight of Water Collected			58.42 gm

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	9.2	9.0	9.2		9.13
VOL % O ₂	9.2	9.2	9.2		9.2
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE B4 R2 Bypass	DATE 	RUN NUMBER # 5
BUILDING NUMBER 	SOURCE NUMBER 	

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.7675	0.2756	.4919
ACETONE WASHINGS (Probe, Front Half Filter)	98.4743	98.4124	0.0619
BACK HALF (if needed)			
	Total Weight of Particulates Collected		.5538 gm

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	125	100	25
IMPINGER 2 (H2O)	120	100	20
IMPINGER 3 (Dry)	6	0	6
IMPINGER 4 (Silica Gel)	222.1	207.56	14.54
	Total Weight of Water Collected		65.54 gm

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	9.2	9.4	9.4		9.33
VOL % O ₂	10.2	10.2	9.9		10.1
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>B4R9 Bypass</i>	DATE	RUN NUMBER <i># 6</i>
BUILDING NUMBER		SOURCE NUMBER

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	<i>0.5701</i>	<i>0.2754</i> <i>0.0754</i>	<i>.2947</i>
ACETONE WASHINGS (Probe, Front Half Filter)	<i>96.3136</i>	<i>96.2738</i>	<i>0.0398</i>
BACK HALF (if needed)			
	Total Weight of Particulates Collected		<i>.3345 gm</i>

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	<i>138</i>	<i>100</i>	<i>38</i>
IMPINGER 2 (H2O)	<i>110</i>	<i>100</i>	<i>10</i>
IMPINGER 3 (Dry)	<i>0</i>	<i>0</i>	<i>0</i>
IMPINGER 4 (Silica Gel)	<i>237.7</i> <i>- 21.2</i> <i>216.4</i>	<i>204.04</i>	<i>12.36</i>
	Total Weight of Water Collected		<i>60.36 gm</i>

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>9.6</i>	<i>9.6</i>	<i>9.4</i>		<i>9.53</i>
VOL % O ₂	<i>9.6</i>	<i>9.4</i>	<i>9.3</i>		<i>9.43</i>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

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APPENDIX H

Boiler 4, Scrubber Stack

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S O U R C E T E S T R E P O R T

SOURCE :
 GRISSOM AFB CENTRAL HEATING PLANT
 GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #4:SCRUBBER STACK

DATE TESTED : 22 NOV 87

SUBMITTING AGENCY :
 USAFOEHL/ECQ
 BROOKS AFB, TX 78235

DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: SCRUBBER Stack diameter at ports: 5.0 (ft)
STACK B

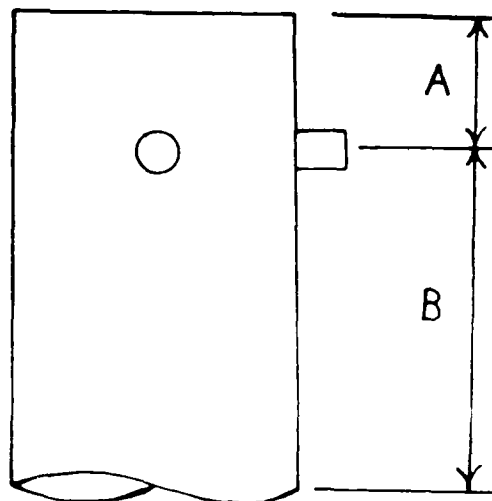
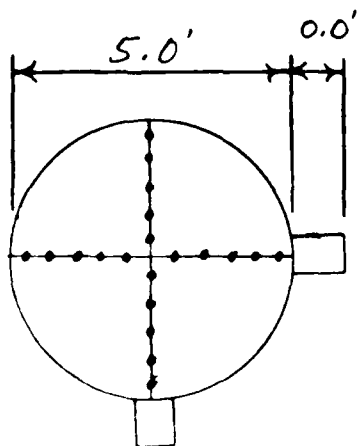
Distance A (ft) 7.0 (duct diameters) 1.4

Recommended number of traverse points as determined by
distance A: 20

Distance B (ft) 28 (duct diameters) 5.6

Recommended number of traverse points as determined by
distance B: 20

Number of traverse points used: 20



TEST TRAVERSE POINT LOCATION

STACK DIAM. (IN.) = 60
STACK RADIUS (IN.) = 30
STACK DIAM. (FT.) = 5
STACK AREA (SQ.FT) = 19.63494

POINT #	DISTANCE IN.
1	1.539501
2	4.9002
3	8.786797
4	13.56832
5	20.51317
6	39.48683
7	46.43168
8	51.21321
9	55.0998
10	58.4605

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5 PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD. TEMP (F) = 68
STD. TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

***** RUN # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 280.9278

AMBIENT WET BULB (K) = 275.9278

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 23.2294 DEG. F.

VAPOR PRESSURE (IN.HG) = .1264235

SATURATION VAPOR PRESS. (IN.HG) = .3103822

RELATIVE HUMIDITY (%) = 40.73154

SPECIFIC HUMIDITY (pp1000) = 2.712726

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20

AMBIENT PRESS. (IN.HG) = 30.13

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	55	55	55	1.69
2	59	55	57	2.04
3	61	56	58.5	2
4	63	56	59.5	2.22
5	64	57	60.5	2.36
6	66	58	62	2.49
7	68	59	63.5	2.49
8	69	60	64.5	2.52
9	70	60	65	2.53
10	71	62	66.5	1.94
11	69	62	65.5	1.37
12	69	63	66	1.82
13	69	63	66	2.16
14	70	63	66.5	2.25
15	70	63	66.5	2.66
16	70	63	66.5	2.57
17	70	63	66.5	2.57
18	70	63	66.5	2.59
19	69	63	66	2.8
20	69	63	66	2.2

FINAL AVG. METER TEMP (R) = 523.7

DELTA H0 VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 30.29643

H 2 O T E S T D A T A

START METER READING = 251.672
END METER READING = 293.905
TOTAL CONDENSATE VOL (ML) = 75.13
H2O VAPOR GAS VOLUME @ STP = 3.561162
TOTAL METER GAS VOL (uncorrected CF) = 42.233
AVG. METER TEMP (R) = 523.7
TOTAL DRY SAMPLE VOL (CF @ STP) = 43.11548
MOLE FRACTION DRY AIR = .9237057
% H2O BY VOL = 7.629431

G A S D E N S I T Y

% CO2 = 4.43
% O2 = 15.1
% CO = 0
% N2 = 78

GAS DENSITY = .9606515

DRY MOL. WT. = 28.6212

SOURCE TEST DATA

NOZZLE DIAM (IN.) = .313
 NOZZLE AREA (FT²) = 5.343376E-04
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 30.13
 STACK PRESS (IN.HG) = 30.1418
 TEST START TIME = 1115

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .17	566 / 515	24.28976	1.69	3
2 / .205	575 / 517	26.88447	2.04	3
3 / .205	580 / 518.5	27.0011	2	3
4 / .225	575 / 519.5	28.16539	2.22	3
5 / .24	576 / 520.5	29.11437	2.36	3
6 / .255	582 / 522	30.16631	2.49	3
7 / .255	585 / 523.5	30.24395	2.49	3
8 / .255	579 / 524.5	30.08846	2.52	3
9 / .255	577 / 525	30.03644	2.53	3
10 / .195	577 / 526.5	26.26611	1.94	3
11 / .135	566 / 525.5	21.6454	1.37	3
12 / .18	566 / 526	24.99396	1.82	3
13 / .22	583 / 526	28.04376	2.16	3
14 / .23	587 / 526.5	28.77223	2.25	3
15 / .27	583 / 526.5	31.06753	2.66	3
16 / .26	581 / 526.5	30.43444	2.57	3
17 / .26	586 / 526.5	30.56511	2.57	3
18 / .267	592 / 526.5	31.132	2.59	3
19 / .29	594 / 526	32.49996	2.8	3
20 / .23	600 / 526	29.08909	2.2	3

TOTAL METER VOLUME = 42.233
 AVG. STACK TEMP (R) = 580.5
 AVG. STACK VEL (FT/SEC) = 28.52499
 AVG. STACK VEL (FT/MIN) = 1711.499
 AVG. METER TEMP (R) = 523.7
 AVG. METER DELTA H (IN.H2O) = 2.2635
 AVG. METER PRESSURE (IN.HG) = 30.29643
 TOTAL MINS OF TEST = 60
 STACK ACFM = 33605.19
 STACK DSCFM = 28432.12

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 75.13
AVERAGE STACK TEMPERATURE (R) = 580.5
TOTAL METER GAS VOL (uncorrected CF) = 42.233
AVG METER TEMP (R) = 523.7
BAROMETRIC PRESSURE (IN.HG) = 30.13
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.2635
AVG. STACK VEL (FT/MIN) = 28.52499
STACK PRESSURE (IN.HG) = 30.1418
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.84558 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .1763
SAMPLE WT. (GMS) = .1763
SAMPLE VOL. (DSCFM) = 43.11548
CONCENTRATION (GR/DSCF) = 6.309356E-02
% CO2 = 4.43
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1709081
STACK DSCFM = 28432.12
PM EMISSIONS (stk conds) (LB/HR) = 15.37537
PM EMISSIONS (@ 12% CO2) (LB/HR) = 41.64887

***** END OF ANALYSIS FOR RUN # 1 *****

***** RUN # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 283.7055

AMBIENT WET BULB (K) = 277.5945

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 24.42685 DEG. F.

VAPOR PRESSURE (IN.HG) = .1328173

SATURATION VAPOR PRESS. (IN.HG) = .374017

RELATIVE HUMIDITY (%) = 35.51102

SPECIFIC HUMIDITY (pp1000) = 2.850159

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20

AMBIENT PRESS. (IN.HG) = 30.13

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	61	60	60.5	1.47
2	62	60	61	1.67
3	62	61	61.5	2.16
4	66	61	63.5	2.39
5	67	62	64.5	2.58
6	69	63	66	2.58
7	71	64	67.5	2.58
8	72	65	68.5	2.47
9	72	65	68.5	2.58
10	72	65	68.5	2.3
11	71	66	68.5	1.5
12	71	66	68.5	1.9
13	72	67	69.5	1.9
14	72	67	69.5	2.18
15	72	67	69.5	2.38
16	73	67	70	2.57
17	74	68	71	2.68
18	74	68	71	2.7
19	75	68	71.5	2.69
20	75	69	72	2.71

FINAL AVG. METER TEMP (R) = 527.55

DELTA H@ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 30.29908

H 2 O T E S T D A T A

START METER READING = 294.253
END METER READING = 336.725
TOTAL CONDENSATE VOL (ML) = 82.74
H2O VAPOR GAS VOLUME @ STP = 3.921876
TOTAL METER GAS VOL (uncorrected CF) = 42.47202
AVG. METER TEMP (R) = 527.55
TOTAL DRY SAMPLE VOL (CF @ STP) = 43.04682
MOLE FRACTION DRY AIR = .9165002
% H2O BY VOL = 8.34998

G A S D E N S I T Y

% CO2 = 4.57
% O2 = 15.63
% CO = 0
% N2 = 78

GAS DENSITY = .9653274

DRY MOL. WT. = 28.8524

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
 NOZZLE AREA (FT2) = 5.343376E-04
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 30.13
 STACK PRESS (IN.HG) = 30.1418
 TEST START TIME = 1313

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .15	580 / 520.5	23.04071	1.47	3
2 / .17	580 / 521	24.5287	1.67	3
3 / .22	580 / 521.5	27.90368	2.16	3
4 / .24	574 / 523.5	28.9933	2.39	3
5 / .26	576 / 524.5	30.22971	2.58	3
6 / .26	579 / 526	30.30834	2.58	3
7 / .26	581 / 527.5	30.36064	2.58	3
8 / .25	583 / 528.5	29.82225	2.47	3
9 / .26	583 / 528.5	30.41285	2.58	3
10 / .23	576 / 528.5	28.43226	2.3	3
11 / .15	576 / 528.5	22.96112	1.5	3
12 / .19	576 / 528.5	25.84189	1.9	3
13 / .19	582 / 529.5	25.97613	1.9	3
14 / .22	582 / 529.5	27.95175	2.18	3
15 / .24	581 / 529.5	29.16956	2.38	3
16 / .26	584 / 530	30.43892	2.57	3
17 / .27	584 / 531	31.01876	2.68	3
18 / .27	579 / 531	30.88569	2.7	3
19 / .27	582 / 531.5	30.9656	2.69	3
20 / .27	579 / 532	30.88569	2.71	3

TOTAL METER VOLUME = 42.47202
 AVG. STACK TEMP (R) = 579.85
 AVG. STACK VEL (FT/SEC) = 28.50638
 AVG. STACK VEL (FT/MIN) = 1710.383
 AVG. METER TEMP (R) = 527.55
 AVG. METER DELTA H (IN.H2O) = 2.2995
 AVG. METER PRESSURE (IN.HG) = 30.29908
 TOTAL MINS OF TEST = 60
 STACK ACFM = 33583.26
 STACK DSCFM = 28223.52

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 82.74
AVERAGE STACK TEMPERATURE (R) = 579.85
TOTAL METER GAS VOL (uncorrected CF) = 42.47202
AVG METER TEMP (R) = 527.55
BAROMETRIC PRESSURE (IN.HG) = 30.13
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.2995
AVG. STACK VEL (FT/MIN) = 28.50638
STACK PRESSURE (IN.HG) = 30.1418
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 100.3641 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .2177
SAMPLE WT. (GMS) = .2177
SAMPLE VOL. (DSCFM) = 43.04682
CONCENTRATION (GR/DSCF) = .0780339
% CO2 = 4.57
CONCENTRATION @ 12% CO2 (GR/DSCF) = .204903
STACK DSCFM = 28223.52
PM EMISSIONS (stk conds) (LB/HR) = 18.8767
PM EMISSIONS (@ 12% CO2) (LB/HR) = 49.56682

***** END OF ANALYSIS FOR RUN # 2 *****

***** RUN # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.

AMBIENT DRY BULB (K) = 284.2611

AMBIENT WET BULB (K) = 278.15

SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 26.14654 DEG. F.

VAPOR PRESSURE (IN.HG) = .1425087

SATURATION VAPOR PRESS. (IN.HG) = .3880618

RELATIVE HUMIDITY (%) = 36.72319

SPECIFIC HUMIDITY (pp1000) = 3.058516

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20

AMBIENT PRESS. (IN.HG) = 30.13

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	68	68	68	1.31
2	68	68	68	1.81
3	69	68	68.5	2.09
4	70	68	69	2.36
5	71	68	69.5	2.79
6	72	68	70	2.67
7	74	68	71	2.57
8	74	68	71	2.77
9	74	68	71	2.65
10	75	68	71.5	2.33
11	73	68	70.5	1.81
12	73	68	70.5	2.07
13	73	68	70.5	2.18
14	73	68	70.5	2.37
15	74	69	71.5	2.58
16	75	69	72	2.78
17	75	69	72	2.88
18	75	69	72	2.87
19	75	69	72	2.86
20	75	69	72	2.65

FINAL AVG. METER TEMP (R) = 530.55

DELTA H@ VALUE = 2.11

FINAL AVG. METER PRESS. (IN.HG) = 30.30794

H 2 O T E S T D A T A

START METER READING = 336.853
END METER READING = 380.615
TOTAL CONDENSATE VOL (ML) = 93.58999
H2O VAPOR GAS VOLUME @ STP = 4.436166
TOTAL METER GAS VOL (uncorrected CF) = 43.762
AVG. METER TEMP (R) = 530.55
TOTAL DRY SAMPLE VOL (CF @ STP) = 44.11634
MOLE FRACTION DRY AIR = .9086316
% H2O BY VOL = 9.136842

G A S D E N S I T Y

% CO2 = 4.53
% O2 = 15.5
% CO = 0
% N2 = 78

GAS DENSITY = .9605196

DRY MOL. WT. = 28.7932

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
 NOZZLE AREA (FT2) = 5.343376E-04
 PITOT FACTOR = .84
 ATMOS. PRESS (IN.HG) = 30.13
 STACK PRESS (IN.HG) = 30.1418
 TEST START TIME = 1500

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .13	572 / 528	21.35453	1.31	3
2 / .18	572 / 528	25.12781	1.81	3
3 / .21	579 / 528.5	27.3067	2.09	3
4 / .24	586 / 529	29.36803	2.36	3
5 / .28	580 / 529.5	31.55828	2.79	3
6 / .27	585 / 530	31.12291	2.67	3
7 / .26	586 / 531	30.56721	2.57	3
8 / .28	586 / 531	31.7211	2.77	3
9 / .27	590 / 531	31.25563	2.65	3
10 / .24	594 / 531.5	29.56781	2.33	3
11 / .18	574 / 530.5	25.1717	1.81	3
12 / .2	586 / 530.5	26.80922	2.07	3
13 / .22	585 / 530.5	28.09374	2.18	3
14 / .24	586 / 530.5	29.36803	2.37	3
15 / .26	585 / 531.5	30.54112	2.58	3
16 / .28	585 / 532	31.69402	2.78	3
17 / .29	585 / 532	32.25501	2.88	3
18 / .29	586 / 532	32.28257	2.87	3
19 / .29	588 / 532	32.33762	2.86	3
20 / .27	591 / 532	31.2821	2.65	3

TOTAL METER VOLUME = 43.762
 AVG. STACK TEMP (R) = 584.05
 AVG. STACK VEL (FT/SEC) = 29.43925
 AVG. STACK VEL (FT/MIN) = 1766.355
 AVG. METER TEMP (R) = 530.55
 AVG. METER DELTA H (IN.H2O) = 2.42
 AVG. METER PRESSURE (IN.HG) = 30.30794
 TOTAL MINS OF TEST = 60
 STACK ACFM = 34682.27
 STACK DSCFM = 28689.09

ISOKINETIC ANALYSIS

TOTAL CONDENSATE VOLUME (ML) = 93.58999
AVERAGE STACK TEMPERATURE (R) = 584.05
TOTAL METER GAS VOL (uncorrected CF) = 43.762
AVG METER TEMP (R) = 530.55
BAROMETRIC PRESSURE (IN.HG) = 30.13
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.42
AVG. STACK VEL (FT/MIN) = 29.43925
STACK PRESSURE (IN.HG) = 30.1418
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT²) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 101.1234 %

PARTICULATE EMISSION RATE

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .0416
SAMPLE WT. (GMS) = .0416
SAMPLE VOL. (DSCFM) = 44.11634
CONCENTRATION (GR/DSCF) = 1.454989E-02
% CO2 = 4.53
CONCENTRATION @ 12% CO2 (GR/DSCF) = 3.854276E-02
STACK DSCFM = 28689.09
PM EMISSIONS (stk conds) (LB/HR) = 3.577735
PM EMISSIONS (@ 12% CO2) (LB/HR) = 9.477442

***** END OF ANALYSIS FOR RUN # 3 *****

PARTICULATE SAMPLING DATA SHEET

SCHEMATIC OF STACK CROSS SECTION				EQUATIONS				AMBIENT TEMP				
TRaverse POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H ₂ O)	STACK TEMP (°F)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP (°F)	IN (°F)	AVG (T _m) (°F)	OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	115	16	106	1.17	1.69	251.672	55	55	55	55	235	62
2	3	3	105	1.205	2.04		59	59	57	55	235	63
3	3	3	120	1.205	2.0		61	61	58	56	240	63
4	7.5	4	115	1.225	2.22		63	63	59.5	56	256	61
5	12	4	116	1.24	2.36		64	64	60	57	273	61
6	15	5	122	1.255	2.49		66	66	62	58	265	61
7	15	5	125	1.255	2.49		68	68	63.5	59	266	60
8	21	5	119	1.255	2.52		69	69	64.5	60	267	60
9	24	5	117	1.255	2.53		70	70	65	60	265	60
10	27	4.8	117	1.195	1.94	273.727	71	71	66.5	62	265	61
11	1148	3	106	1.135	1.37		69	69	65.5	62	267	61
12	30	3	106	1.18	1.82		69	69	66	63	267	61
13	6	4	123	1.220	2.16		69	69	66	63	265	61
14	9	4.5	127	1.23	2.25		70	70	66.5	63	264	64
15	12	5	123	1.26	2.66		70	70	66.5	63	266	62
16	15	5	121	1.26	2.57		70	70	66.5	63	264	66
17	18	5	126	1.26	2.57		70	70	66.5	63	263	68
18	21	5	132	1.267	2.59		70	70	66.5	63	260	68
19	24	6	134	1.28	2.80		69	69	66	63	261	68
20	27	5	140	1.23	2.20		69	69	66	63	263	65
	30					293.905						
				press 11.517	2.26				63.7			
				120.50		412.233						

AMBIENT TEMP	64.15	of
STATION PRESS	1.13	in Hg
HEATER BOX TEMP		of
PROBE HEATER SETTING		
PROBE LENGTH	6.6155	in
NOZZLE AREA (A)	.313/.313/.313	sq ft
Cp	1.84	
DRY GAS FRACTION (Fd)	6.2	

EQUATIONS

$$^{\circ}R = ^{\circ}F + 460$$

$$H = \left[\frac{5130 \cdot F_d \cdot C_p \cdot A}{C_o} \right]^2 \cdot \frac{T_m}{T_s} \cdot V_P$$

SCHEMATIC OF STACK SECTION

RUN #3

LEAK CK @ 7 Hg = 57/100

3000/PT

RIN NUMBER	SQUIDDER/BOLLEN 4 DATE 22 NOV 87
PLANT	LOWEN HUNT
BASE	GRISSON HAB
SAMPLE BOX NUMBER	RIM
METER BOX NUMBER	NALIC
	60

[illegible]

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <i>B4R1 Scrubber</i>	DATE	RUN NUMBER <i># 7</i>
BUILDING NUMBER	SOURCE NUMBER	

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	<i>0.2997</i>	<i>0.2766</i>	<i>0.0231</i>
ACETONE WASHINGS (Probe, Front Half Filter)	<i>100.2818</i>	<i>100.1286</i>	<i>0.1532</i>
BACK HALF (if needed)			
	Total Weight of Particulates Collected		<i>0.1763 gm</i>

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	<i>117</i>	<i>100</i>	<i>17</i>
IMPINGER 2 (H2O)	<i>145</i>	<i>100</i>	<i>45</i>
IMPINGER 3 (Dry)	<i>2</i>	<i>0</i>	<i>2</i>
IMPINGER 4 (Silica Gel) <i>237.4</i> <i>2021.3</i>	<i>216.10</i> <i>237.4</i>	<i>204.97</i>	<i>11.13</i>
	Total Weight of Water Collected		<i>75.13 gm</i>

III. GASES (Dn)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	<i>4.6</i>	<i>4.3</i>	<i>4.4</i>		<i>4.43</i>
VOL % O ₂	<i>15.2</i>	<i>15.1</i>	<i>15.0</i>		<i>15.1</i>
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER # 9
------	------	-------------------

FIELDING NUMBER Sample B# 4 R# 2	SOURCE NUMBER
-------------------------------------	---------------

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3085	0.2772	0.0313
ACETONE WASHINGS (Probe, Front Half Filter)	99.8000	99.6136	0.1864
BACK HALF (if needed)			
Total Weight of Particulates Collected			0.2177 gm

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H ₂ O)	126	100	26
IMPINGER 2 (H ₂ O)	134	100	34
IMPINGER 3 (Dry)	6.4	0	6.4
IMPINGER 4 (Silica Gel) 244.1 21.3	222.80	206.46	16.34
100 100.02 10 10.01 0.5 0.504	Total Weight of Water Collected		82.74 gm

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	4.6	4.6	4.5		4.57
VOL % O ₂	15.6	15.8	15.5		15.63
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE <div style="font-size: 1.5em; font-family: cursive;">B4R3 Scrubber</div>	DATE 	RUN NUMBER <div style="font-size: 1.5em; font-family: cursive;"># 10</div>
BUILDING NUMBER 	SOURCE NUMBER 	

I. PARTICULATES			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3011	0.2772	0.0239
ACETONE WASHINGS (Probe, Front Half Filter)	97.6740	97.6563	0.0177
BACK HALF (if needed)			
Total Weight of Particulates Collected			0.0416

II. WATER			
ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H2O)	108	100	58
IMPINGER 2 (H2O)	118	100	18
IMPINGER 3 (Dry)	4	0	4
IMPINGER 4 (Silica Gel)	215.9	202.31	13.59
Total Weight of Water Collected			93.59

III. GASES (Dry)					
ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO ₂	4.4 4.6	4.6	4.6		4.53
VOL % O ₂	15.6 20.0	15.5 20.1	15.4 20.1		15.5
VOL % CO					
VOL % N ₂					

$$\text{Vol \% N}_2 = (100\% - \% \text{CO}_2 - \% \text{O}_2 - \% \text{CO})$$

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APPENDIX I

EPA Computer Program Emission Calculations

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XROM -METH-5

RUN NUMBER
B3-EP-R1
METER BOX Y? RUN
1.0020 RUN
DELTA H? RUN
1.7200 RUN
BAR PRESS ? RUN
29.4200 RUN
METER VOL ? RUN
35.7930 RUN
NTR TEMP F? RUN
51.5000 RUN
STATIC HOH IN ? RUN
.0500 RUN
STACK TEMP.
420.0000 RUN
ML. WATER ? RUN
50.0000 RUN

IMP. % HOH = 5.6

% HOH=5.6

% CO2?

10.1700 RUN

% OXYGEN?

9.3700 RUN

% CO ?

RUN

MWd =30.00

MW WET=29.33

SART PSTS ?

6.2913 RUN

TIME MIN ?

60.0000 RUN

NOZZLE DIA ?

.4900 RUN

STK DIA INCH ?

66.0000 RUN

* VOL MTR STD = 39.478
STK PRES ABS = 29.42
VOL HOH GAS = 2.36
% MOISTURE = 5.63
MOL DRY GAS = 0.944
% NITROGEN = 80.46
MOL WT DRY = 30.00
MOL WT WET = 29.33
VELOCITY FPS = 15.78
STACK AREA = 23.76
STACK ACFM = 21.924.
* STACK DSCFM = 12.200.
% ISOINETIC = 94.72

END OF FIELD DATA

XROM -METH-5

RUN NUMBER
B3-EP-R2
VOL MTR STD ? RUN
39.478 RUN
STACK DSCFM ? RUN
12.200.00 RUN
FRONT 1/2 MG ? RUN
271.90 RUN
BACK 1/2 MG ? RUN

F GR/DSCF = 0.11
F MG/MM = 243.22
F LB/HR = 11.12
F KG/HR = 5.04

XROM -METH-5

RUN NUMBER
B3-EP-R2
METER BOX Y? RUN
1.0020 RUN
DELTA H? RUN
1.6900 RUN
BAR PRESS ? RUN
29.3870 RUN
METER VOL ? RUN
35.3410 RUN
NTR TEMP F? RUN
52.7000 RUN
STATIC HOH IN ? RUN
.0900 RUN
STACK TEMP.
426.2000 RUN
ML. WATER ? RUN
60.3400 RUN

IMP. % HOH = 6.8

% HOH=6.8

% CO2?

10.6700 RUN

% OXYGEN?

8.0700 RUN

% CO ?

RUN

MWd =30.03

MW WET=29.21

SART PSTS ?

6.0854 RUN

TIME MIN ?

60.0000 RUN

NOZZLE DIA ?

.4900 RUN

STK DIA INCH ?

66.0000 RUN

* VOL MTR STD = 30.042
STK PRES ABS = 29.39
VOL HOH GAS = 2.84
% MOISTURE = 6.01
MOL DRY GAS = 0.932
% NITROGEN = 81.26
MOL WT DRY = 30.03
MOL WT WET = 29.21
VELOCITY FPS = 14.91
STACK AREA = 23.76
STACK ACFM = 21.260.
* STACK DSCFM = 11.596.
% ISOINETIC = 98.11

END OF FIELD DATA

XROM -METH 5-
 RUN NUMBER
 B3-SC-R1

METER BOX Y? 1.0820 RUN
 DELTA H? 1.5900 RUN
 BAR PRESS ? 29.2000 RUN
 METER VOL ? 34.1990 RUN
 MTR TEMP F? 38.1300 RUN
 STATIC HON IN ? .0700 RUN
 STACK TEMP. 437.7000 RUN
 ML. WATER ? 56.7500 RUN

IMP. % HON = 6.5

% HON=6.5

% CO2? 10.1000 RUN
 % OXYGEN? 8.5300 RUN
 % CO ? RUN

MWD =29.96
 MW MET=29.18

SORT PSTS ? 6.0611 RUN
 TIME MIN ? 60.0000 RUN
 NOZZLE DIA ? .4900 RUN
 STK DIA INCH ? 66.0000 RUN

* VOL MTR STD = 38.431
 STK PRES ABS = 29.21
 VOL HON GAS = 2.67
 % MOISTURE = 6.50
 MOL DRY GAS = 0.935
 % NITROGEN = 81.37
 MOL WT DRY = 29.96
 MOL WT WET = 29.18
 VELOCITY FPS = 14.91
 STACK AREA = 23.76
 STACK ACFM = 21.254.
 * STACK DSCFM = 11.409.
 % ISOKINETIC = 98.67

END OF FIELD DATA

XROM -METH 5-

RUN NUMBER
 B3-SC-R1
 VOL MTR STD ? 38.431 RUN
 STACK DSCFM ? 11.409.00 RUN
 FRONT 1/2 MG ? 381.20 RUN
 BACK 1/2 MG ? RUN

F GR/DSCF = 0.15
 F MG/MM = 350.28
 F LB/HR = 14.97
 F KG/HR = 6.79

RUN NUMBER
 B3 SC R1
 VOL MTR STD ? 51.085 RUN
 STACK DSCFM ? 31.392.00 RUN
 FRONT 1/2 MG ? 1.147.00 RUN
 BACK 1/2 MG ? RUN

F GR/DSCF = 0.35
 F MG/MM = 792.90
 F LB/HR = 93.23
 F KG/HR = 42.29

XROM -METH 5-
 RUN NUMBER
 B3-SC-R1

METER BOX Y? 1.0820 RUN
 DELTA H? 2.8300 RUN
 BAR PRESS ? 29.0200 RUN
 METER VOL ? 47.3240 RUN
 MTR TEMP F? 57.0000 RUN
 % OTHER GAS REMOVED BEFORE DRY GAS METER ? RUN
 STATIC HON IN ? .1200 RUN
 STACK TEMP. 112.9000 RUN
 ML. WATER ? 80.0000 RUN

SAT % = 9.7
 IMP. % HON = 6.9

% HON=6.9

% CO2? 3.3700 RUN
 % OXYGEN? 16.8300 RUN
 % CO ? RUN

MOL WT OTHER? RUN

MWD =29.21
 MW MET=28.44
 SORT PSTS ? 12.8100 RUN
 TIME MIN ? 60.0000 RUN
 NOZZLE DIA ? .3130 RUN
 STK DIA INCH ? 60.0000 RUN

* VOL MTR STD = 51.085
 STK PRES ABS = 29.03
 VOL HON GAS = 3.80
 % MOISTURE = 6.93
 MOL DRY GAS = 0.931
 % NITROGEN = 79.00
 MOL WT DRY = 29.21
 MOL WT WET = 28.44
 VELOCITY FPS = 32.02
 STACK AREA = 19.63
 STACK ACFM = 37.721.
 * STACK DSCFM = 31.392.
 % ISOKINETIC = 99.72

END OF FIELD DATA

XROM ~~METH~~
 RUN NUMBER
~~83-SC-82~~

METER BOX Y? RUN
 1.0820 RUN
 DELTA H? RUN
 2.0875 RUN
 BAR PRESS ? RUN
 29.0200 RUN
 METER VOL ? RUN
 47.5820 RUN
 MTR TEMP F? RUN
 65.3900 RUN
 STATIC HOH IN ? RUN
 .1200 RUN
 STACK TEMP. RUN
 112.1000 RUN
 ML. WATER ? RUN
 81.6300 RUN

SAT λ = 9.5

IMP. λ HOH = 7.1

λ HOH=7.1

λ CO2? RUN
 3.0300 RUN
 λ OXYGEN? RUN
 17.3000 RUN
 λ CO ? RUN

MWD =29.18
 MW WET=28.39

SOFT PSTS ? RUN
 12.6409 RUN
 TIME MIN ? RUN
 60.0000 RUN
 NOZZLE DIA ? RUN
 .3130 RUN
 STK DIA INCH ? RUN
 60.0000 RUN

* VOL MTR STD = 58.540
 STK PRES ABS = 29.03
 VOL HOH GAS = 3.84
 λ MOISTURE = 7.07
 MOL DRY GAS = 0.929
 λ NITROGEN = 79.67
 MOL WT DRY = 29.18
 MOL WT WET = 28.39
 VELOCITY FPS = 31.62
 STACK AREA = 19.63
 STACK ACFM = 37.254.
 * STACK DSCFM = 31.002.
 λ ISOKINETIC = 99.90

END OF FIELD DATA

XROM ~~MASSEP~~

RUN NUMBER
~~83-SC-82~~ RUN
 VOL MTR STD ? RUN
 58.54 RUN
 STACK DSCFM ? RUN
 31.002.00 RUN
 FRONT 1/2 MG ? RUN
 482.60 RUN
 BACK 1/2 MG ? RUN

F GR/DSCF = 8.12
 F MG/MMH = 281.31
 F LB/HR = 32.67
 F KG/HR = 14.82

XROM ~~METH~~
 RUN NUMBER
~~83-SC-82~~

METER BOX Y? RUN
 1.0820 RUN
 DELTA H? RUN
 2.9575 RUN
 BAR PRESS ? RUN
 29.0200 RUN
 METER VOL ? RUN
 48.9090 RUN
 MTR TEMP F? RUN
 72.5300 RUN
 STATIC HOH IN ? RUN
 .1200 RUN
 STACK TEMP. RUN
 120.0000 RUN
 ML. WATER ? RUN
 82.2600 RUN

SAT λ = 12.1

IMP. λ HOH = 7.0

λ HOH=7.0

λ CO2? RUN
 3.1000 RUN
 λ OXYGEN? RUN
 17.0000 RUN
 λ CO ? RUN

MWD =29.18
 MW WET=28.39

SOFT PSTS ? RUN
 13.0836 RUN
 TIME MIN ? RUN
 60.0000 RUN
 NOZZLE DIA ? RUN
 .3130 RUN
 STK DIA INCH ? RUN
 60.0000 RUN

* VOL MTR STD = 51.272
 STK PRES ABS = 29.03
 VOL HOH GAS = 3.87
 λ MOISTURE = 7.02
 MOL DRY GAS = 0.930
 λ NITROGEN = 79.90
 MOL WT DRY = 29.18
 MOL WT WET = 28.39
 VELOCITY FPS = 32.73
 STACK AREA = 19.63
 STACK ACFM = 39.556.
 * STACK DSCFM = 31.619.
 λ ISOKINETIC = 99.37

XROM -MAGGEL-
 RUN NUMBER
~~B4-B-R2~~
 RUN
 METER BOX Y?
 1.0820 RUN
 DELTA H?
 1.4600 RUN
 BAR PRESS ?
 30.3300 RUN
 METER VOL ?
 32.9920 RUN
 MTR TEMP F?
 49.7100 RUN
 STATIC HOH IN ?
 .1100 RUN
 STACK TEMP.
 419.3000 RUN
 ML. WATER ?
 58.4200 RUN

IMP. % HOH = 6.8

% HOH=6.8

% CO2?
 9.1300 RUN
 % OXYGEN?
 9.2000 RUN
 % CO ?
 RUN

MWD =29.83
 MW WET=29.02

SOFT PSTS ?
 5.6318 RUN
 TIME MIN ?
 60.0000 RUN
 NOZZLE DIA ?
 .4980 RUN
 STK DIA INCH ?
 66.0000 RUN

* VOL MTR STD = 37.618
 STK PRES ABS = 30.34
 VOL HOH GAS = 2.75
 % MOISTURE = 6.81
 MOL DRY GAS = 0.932
 % NITROGEN = 81.67
 MOL WT DRY = 29.83
 MOL WT WET = 29.02
 VELOCITY FPS = 13.63
 STACK AREA = 23.76
 STACK ACFM = 19.429.
 * STACK DSCFM = 11.024.
 % ISOKINETIC = 99.95

XROM -MAGGEL-
 RUN NUMBER
~~B4-B-R2~~
 CLX
 RUN
 VOL MTR STD ?
 37.618 RUN
 STACK DSCFM ?
 11.024.00 RUN
 FRONT 1/2 MG ?
 413.90 RUN
 BACK 1/2 MG ?
 RUN
 F GR/DSCF = 0.17
 F MG/MMM = 380.53
 F LB/HR = 16.04
 F KG/HR = 7.28

XROM -MAGGEL-
 RUN NUMBER
~~B4-B-R2~~
 RUN
 METER BOX Y?
 1.0820 RUN
 DELTA H?
 1.6525 RUN
 BAR PRESS ?
 30.3300 RUN
 METER VOL ?
 35.5300 RUN
 MTR TEMP F?
 56.6700 RUN
 STATIC HOH IN ?
 .1100 RUN
 STACK TEMP.
 413.0000 RUN
 ML. WATER ?
 65.5400 RUN

IMP. % HOH = 7.2

% HOH=7.2

% CO2?
 9.3300 RUN
 % OXYGEN?
 10.1000 RUN
 % CO ?
 RUN

MWD =29.90
 MW WET=29.04

SOFT PSTS ?
 5.9301 RUN
 TIME MIN ?
 60.0000 RUN
 NOZZLE DIA ?
 .4980 RUN
 STK DIA INCH ?
 66.0000 RUN

* VOL MTR STD = 39.993
 STK PRES ABS = 30.34
 VOL HOH GAS = 3.00
 % MOISTURE = 7.16
 MOL DRY GAS = 0.928
 % NITROGEN = 80.57
 MOL WT DRY = 29.90
 MOL WT WET = 29.04
 VELOCITY FPS = 14.37
 STACK AREA = 23.76
 STACK ACFM = 20.478.
 * STACK DSCFM = 11.659.
 % ISOKINETIC = 100.43

XROM -METH-
 RUN NUMBER
~~B4-03-03~~
 METER BOX Y? RUN
 1.0820 RUN
 DELTA H? RUN
 1.5200 RUN
 BAR PRESS ? RUN
 30.3300 RUN
 METER VOL ? RUN
 34.5910 RUN
 MTR TEMP F? RUN
 65.9600 RUN
 STATIC HOH IN ? RUN
 .1100 RUN
 STACK TEMP. RUN
 420.9000 RUN
 ML. WATER ? RUN
 60.3600 RUN

IMP. % HOH = 6.9

% HOH=6.9

% CO2?

9.5300 RUN

% OXYGEN?

9.4300 RUN

% CO ?

RUN

MWD =29.90

MW MET=29.00

SORT PSTS ?

5.6760 RUN

TIME MIN ?

60.0000 RUN

NOZZLE DIA ?

.4900 RUN

STK DIA INCH ?

66.0000 RUN

- * VOL MTR STD = 30.228
- STK PRES ABS = 30.34
- VOL HOH GAS = 2.84
- % MOISTURE = 6.92
- MOL DRY GAS = 0.931
- % NITROGEN = 81.04
- MOL WT DRY = 29.90
- MOL WT WET = 29.03
- VELOCITY FPS = 13.73
- STACK AREA = 23.76
- STACK ACFM = 13.565.
- * STACK DSCFM = 11.062.
- % ISOKINETIC = 101.16

END OF FIELD DATA

XROM -METH-
 RUN NUMBER
~~B4-03-03~~
 METER BOX Y? RUN
 1.0820 RUN
 DELTA H? RUN
 1.5200 RUN
 BAR PRESS ? RUN
 30.3300 RUN
 METER VOL ? RUN
 34.5910 RUN
 MTR TEMP F? RUN
 65.9600 RUN
 STATIC HOH IN ? RUN
 .1100 RUN
 STACK TEMP. RUN
 420.9000 RUN
 ML. WATER ? RUN
 60.3600 RUN

F GR/DSCF = 0.14
 F MG/MMH = 309.00
 F LB/HP = 12.81
 F KG/HR = 5.81

CLX
 XROM -METH-
 RUN NUMBER
~~B4-03-03~~
 METER BOX Y? RUN
 1.0820 RUN
 DELTA H? RUN
 1.5200 RUN
 BAR PRESS ? RUN
 30.3300 RUN
 METER VOL ? RUN
 34.5910 RUN
 MTR TEMP F? RUN
 65.9600 RUN
 STATIC HOH IN ? RUN
 .1100 RUN
 STACK TEMP. RUN
 420.9000 RUN
 ML. WATER ? RUN
 60.3600 RUN

F GR/DSCF = 0.06
 F MG/MMH = 133.46
 F LB/HP = 14.15
 F KG/HR = 6.42

XROM -METH-
 RUN NUMBER
~~B4-03-03~~
 METER BOX Y? RUN
 1.0820 RUN
 DELTA H? RUN
 1.5200 RUN
 BAR PRESS ? RUN
 30.3300 RUN
 METER VOL ? RUN
 34.5910 RUN
 MTR TEMP F? RUN
 65.9600 RUN
 STATIC HOH IN ? RUN
 .1100 RUN
 STACK TEMP. RUN
 420.9000 RUN
 ML. WATER ? RUN
 60.3600 RUN

SAT % = 11.6

IMP. % HOH = 7.0

% HOH=7.0

% CO2?

4.4300 RUN

% OXYGEN?

15.1000 RUN

% CO ?

RUN

MWD =29.31

MW MET=20.52

SORT PSTS ?

11.5195 RUN

TIME MIN ?

60.0000 RUN

NOZZLE DIA ?

.3130 RUN

STK DIA INCH ?

60.0000 RUN

- * VOL MTR STD = 46.650
- STK PRES ABS = 30.14
- VOL HOH GAS = 3.54
- % MOISTURE = 7.05
- MOL DRY GAS = 0.930
- % NITROGEN = 80.47
- MOL WT DRY = 29.31
- MOL WT WET = 28.52
- VELOCITY FPS = 26.22
- STACK AREA = 19.63
- STACK ACFM = 33.242.
- * STACK DSCFM = 20.313.
- % ISOKINETIC = 100.97

END OF FIELD DATA

XROM -METH-5

RUN NUMBER
~~B4-S0-R2~~
 METER BOX Y? RUN
 1.0020 RUN
 DELTA H? RUN
 2.3000 RUN
 BAR PRESS ? RUN
 30.1300 RUN
 METER VOL ? RUN
 42.4720 RUN
 MTR TEMP F? RUN
 67.4000 RUN
 STATIC HOH IN ? RUN
 .1600 RUN
 STACK TEMP. RUN
 119.8500 RUN
 ML. WATER ? RUN
 82.7400 RUN

SAT % = 11.4

IMP. % HOH = 7.7

% HOH=7.7

% CO2?

4.5700 RUN

% OXYGEN? RUN

15.6300 RUN

% CO ? RUN

MWD =29.36

MW WET=28.40

SORT PSTS ?

11.5400 RUN

TIME MIN ? RUN

60.0000 RUN

NOZZLE DIA ? RUN

.3130 RUN

STK DIA INCH ? RUN

60.0000 RUN

* VOL MTR STD = 46.583
 STK PRES ABS = 30.14
 VOL HOH GAS = 3.89
 % MOISTURE = 7.72
 MOL DRY GAS = 0.923
 % NITROGEN = 79.60
 MOL WT DRY = 29.36
 MOL WT WET = 28.48
 VELOCITY FPS = 28.28
 STACK AREA = 19.63
 STACK ACFM = 33.322.
 * STACK DSCFM = 28.209.
 % ISOINETIC = 101.20

END OF FIELD DATA

XROM -MAGSFL0-

RUN NUMBER
~~B4-S0-R2~~
 RUN
 VOL MTR STD ? RUN
 46.583 RUN
 STACK DSCFM ? RUN
 28.209.00 RUN
 FRONT 1/2 MG ? RUN
 217.70 RUN
 BACK 1/2 MG ? RUN

F GR/DSCF = 0.07
 F MG/MM = 165.04
 F LB/HR = 17.44
 F KG/HR = 7.91

XROM -MAGSFL0-

RUN NUMBER
~~B4-S0-R3~~
 RUN
 VOL MTR STD ? RUN
 47.734 RUN
 STACK DSCFM ? RUN
 28.660.00 RUN
 FRONT 1/2 MG ? RUN
 41.60 RUN
 BACK 1/2 MG ? RUN

F GR/DSCF = 0.01
 F MG/MM = 30.78
 F LB/HR = 3.20
 F KG/HR = 1.50

XROM -METH-5

RUN NUMBER
~~B4-S0-R3~~
 METER BOX Y? RUN
 1.0020 RUN
 DELTA H? RUN
 2.4200 RUN
 BAR PRESS ? RUN
 30.1300 RUN
 METER VOL ? RUN
 43.7620 RUN
 MTR TEMP F? RUN
 70.5500 RUN
 STATIC HOH IN ? RUN
 .1600 RUN
 STACK TEMP. RUN
 124.0500 RUN
 ML. WATER ? RUN
 93.5900 RUN

SAT % = 12.7

IMP. % HOH = 8.4

% HOH=8.4

% CO2?

4.5300 RUN

% OXYGEN? RUN

15.5000 RUN

% CO ? RUN

MWD =29.34

MW WET=28.39

SORT PSTS ?

11.8879 RUN

TIME MIN ? RUN

60.0000 RUN

NOZZLE DIA ? RUN

.3130 RUN

STK DIA INCH ? RUN

60.0000 RUN

* VOL MTR STD = 47.734
 STK PRES ABS = 30.14
 VOL HOH GAS = 4.41
 % MOISTURE = 8.45
 MOL DRY GAS = 0.916
 % NITROGEN = 79.97
 MOL WT DRY = 29.34
 MOL WT WET = 29.39
 VELOCITY FPS = 29.19
 STACK AREA = 19.63
 STACK ACFM = 34.383.
 * STACK DSCFM = 28.660.
 % ISOINETIC = 102.03

END OF FIELD DATA

APPENDIX J
Calibration Data

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METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 28 Oct 87

Meter box number 11111

Barometric pressure, $P_b = 29.575$ in. Hg Calibrated by Daly

Orifice manometer setting (ΔH), in. H ₂ O	Gas volume		Temperature				Time (θ), min	Y_i	$\Delta H \theta$ in. H ₂ O
	Wet test meter (V_w), ft ³	Dry gas meter (V_d), ft ³	Wet test meter (t_w), °F/R	Dry gas meter					
				Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F	Avg ^a (t_d), °F			
VAC- 6 0.5	5	4.672	74 534	75	75	535.5	13.25	1.072	2.056
6 1.0	5	4.684	73 533.5	85	75	540	9.33	1.078	2.096
6 1.5	10	9.376	74 533.5	80	70	543.75	15.40	1.083	2.067
6 2.0	10	9.400	73 533	73	71	547	13.40	1.086	2.126
6 3.0	10	9.441	73 533	77	75	550.5	11.10	1.086	2.126
6 4.0	10	9.433	74 533.5	78	87	553	9.55	1.088	2.171
Avg								1.082	2.11

ΔH , in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t + 460)}$	$\Delta H \theta_i = \frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460) \theta}{V_w} \right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

^a If there is only one thermometer on the dry gas meter, record the temperature under t_d .

FOUNTLETT DRY GAS METER CALIBRATION DATA FORM (English units)

Test number 1 Date 24 Nov 87 Meter box number W4262 Plant Prison
 Barometric pressure, P_b 30.34 in. Hg Dry gas meter number rated Pretest Y 1.082

Orifice manometer setting, (ΔH), in. H_2O	Gas volume		Temperature			Vacuum setting, in. Hg	Y_1	Y_1 $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$
	Wet test meter (V_w), ft ³	Dry gas meter (V_d), ft ³	Wet test meter (t_w), °F	Inlet (t_{d_i}), °F	Outlet (t_{d_o}), °F			
<u>2</u>	<u>10</u>	<u>9.33</u>	<u>76</u>	<u>78</u>	<u>78</u>	<u>21</u>	<u>1.0781</u>	
<u>2</u>	<u>10</u>	<u>9.33</u>	<u>77</u>	<u>78</u>	<u>78</u>	<u>21</u>	<u>1.0789</u>	
<u>2</u>	<u>10</u>	<u>9.33</u>	<u>77</u>	<u>78</u>	<u>78</u>	<u>21</u>	<u>1.0771</u>	
							$Y = 1.078$	

^a If there is only one thermometer on the dry gas meter, record the temperature under t_d where

V_w = Gas volume passing through the wet test meter, ft³.

V_d = Gas volume passing through the dry gas meter, ft³.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o} , °F.

ΔH = Pressure differential across orifice, in. H_2O .

Y_1 = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest $Y \pm 0.05Y$.

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

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NOZZLE CALIBRATION DATA FORM

Date See Below Calibrated by M. Haly

Nozzle identification number	Nozzle Diameter ^a			ΔD , ^b mm (in.)	D_{avg} ^c
	D_1 , mm (in.)	D_2 , mm (in.)	D_3 , mm (in.)		
Scrubber stack boiler 3 + 4 $d \approx .325$	0.313	0.313	0.313	0.000	0.313
Bypass stack boiler 3 + 4 $d \approx 0.500$	0.498	0.499	0.498	0.001	0.498

where:

^a $D_{1,2,3}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

^b ΔD = maximum difference between any two diameters, mm (in.),
 $\Delta D \leq (0.10 \text{ mm}) 0.004 \text{ in.}$

^c D_{avg} = average of D_1 , D_2 , and D_3 .

ANALYTICAL BALANCE CALIBRATION FORM

Balance name See Below Number _____Classification of standard weights Class S weights

Date	0.500 g	1.0000 g	10.0000 g	50.0000 g	100.0000 g	Analyst
Mettler FT 1200						
9 Nov 87	0.47	0.97	9.97	49.98	99.97	MD
Triple Beam Balance 19 Nov	0.5		10.00		100.00	MD
20 Nov	0.375		10.00		100.00	MD
22 Nov	0.504		10.01		100.02	MD
Mettler AE 163						
10 Nov 87	0.4999	1.0000	10.0002	50.0009	100.0017	MD
18 Nov 87	0.5000	1.0001	10.0003			MD
28 Dec		1.0000	9.9996	49.9981		MD
29 Dec		1.0000		49.9981	99.9964	MD
30 Dec		1.0000	9.9997			MD
1 Jan 88		0.9999	9.9996		99.9965	MD

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